JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

SEPTEMBER, 1848.

CIVIL ENGINEERING.

Report of the Engineer of the Atlantic and St. Lawrence Railroad Company.

ENGINEER DEPARTMENT, PORTLAND, July 10, 1848.

Hon. W. P. Preble, President Atlantic and St. Lawrence R. R. Co.

SIR,—The period has arrived when it becomes my duty to submit a report of the operations of this Department, during the year ending on the first of July.

I. *Grading and Bridging.*—At the date of my last annual report, there were 47¼ miles of road located, 28¼ miles under contract, and a considerable amount of work done. In the month of August last, the remaining portion of the line then located, was let to responsible contractors, and the work soon thereafter commenced.

The grading of the first 11¼ miles, with the exception of some heavy work, was finished last year, and the whole, together with the large amount of bridging on this division of the road, was completed in March last.

The second division, 17¼ miles in length, was put under contract in November, 1846, but owing to the unfavorable weather during the succeeding winter and spring, only a small amount of work was done. The whole of this work, except one section west of the junction of the Androscoggin and Kennebec road, may now be regarded as substantially finished, nothing of consequence remaining to be done, except the trimming of the slopes and road-bed, giving a total distance graded, for the reception of the track, of 27½ miles.

The grading on a portion of the third division, comprising an addi-

tional distance of 11 miles, is rapidly progressing, and more than half the work done. This carries the road to Mechanic Falls.

The excavation and embankment have been laid out for a single track, having a width in excavation of 22 feet and 15 feet on embankment. Where there was a surplus of earth excavation over embankment, it was deposited in the road-bed, thus forming a double track embankment; and in some cases where there was a deficiency of earth in the cuts for embankment, the deficiency was made up by enlarging the cuts for a double track. The aggregate length of double track road is six miles.

The soil of the portion of the road now graded, is much of it of an unfavorable description, it being mostly hard, blue clay, which on exposure to frost and rains assumes an unstable and treacherous character. The slopes are liable to slide, and therefore require close attention and some additional expenditure to preserve and render them permanent. This is particularly the case between Portland and North Yarmouth, and also on sections No. 14 and 15. In several of the cuts, quick-sand of a troublesome character has been encountered, requiring much precaution to give stability to the road-bed. In all cuttings where the soil is of an unsuitable character for road-bed, the earth has been removed from 1½ to 3 feet below grade, and the space filled in with good material. The embankments, also, when formed of clay, are covered with gravel, which is indispensable to a permanent road-bed. As your road advances into the interior, the soil is of a more sandy and gravelly character, and a considerable portion will require no additional ballasting to sustain the track.

In the construction of the larger and more important mechanical structures, provision has been made for a double track. Protection walls are also placed in a proper position to sustain double track embankment. The masonry of Presumpscot Bridge, and other structures which cannot be enlarged hereafter without great difficulty and excessive cost, have been designed for a double track. The masonry of the bridges is formed of the best granite, laid in courses with alternate headers and stretchers, and is of the most substantial character. Nothing has been expended for ornament, but the whole has been planned solely with reference to economy and permanency. In the execution of the work for the Presumpscot Bridge, difficulties of a formidable character were encountered. The site of the south abutment was at a point where the mud and water varied in depth from 3 to 12 feet below low water, and the average rise of tide was 10 feet. The surface of the rock was found to be extremely irregular, and covered with alternate layers of hard and soft earth, in which boulders and logs were imbedded.

The irregularity of the rock and the unfavorable nature of the material covering it, rendered the use of piles for the foundation impracticable; and, for the same reasons, the adoption of a coffer dam, for the purpose of removing the earth and founding the masonry on the rock, would have been attended with delay and great expense.

The plan adopted was, first to remove the earth from the rock, which was done by an under-water excavator, after which to frame

12 inch hewn timber into squares of 3½ feet each from centre to centre, of sticks, by halving and spiking each at their intersection. The first course was framed so as to fit the lowest part of the rock, and, as the successive courses were added, each was made to conform to the surface of rock, as the bearing was increased, till the wood-work covered the whole space for the foundation; after which it was carried up perpendicularly to a point 3 feet below low water, and upon this two courses of timber running in opposite directions, were spiked, upon which the masonry was commenced. Although a portion of the masonry rests directly on the rock, and another portion on a timber foundation of over 10 feet depth, no unequal settling took place during the progress of the work, nor has the least change since been observed in any part of the masonry.

A portion of the protection wall at this point was somewhat disturbed by the pressure of the embankment, which is over 40 feet high, on the soft material at the bottom, but proper measures were immediately taken which prevented any further movement. It has since been completed and incorporated with the wings of the abutment in a permanent manner, and appears of a substantial and durable character.

The masonry of most of the other bridges rests on pile foundation, and was laid below water line by the use of coffer dams.

The main walls of culverts are generally of substantial dry rubble masonry, the wings, parapets, and coping being hammer dressed masonry.

The wood work of the truss bridges is constructed on the plan of "How's patent improved," having cast iron bearings. The plans of this work were prepared with much care, and with reference to the heavy engines and great traffic which will pass over the road. A much larger amount of material was required in the construction of the bridges, than is usual on other roads, and it is so disposed as to give strength and stability to those parts which heretofore have first failed, and more durability to the whole structure. They are arranged for a single track, and such provision made as will permit the addition of a second track hereafter, without any interruption of the traffic of the road, or difficulty in the execution of the work. These bridges should all be cased and protected from fire and exposure to the weather, by tin roofs.

The total length of truss bridging on the portion of the road now graded, is 870 feet, which has cost an average of $17·12 per foot of bridge.

The total length of pile bridging is nearly three quarters of a mile, and the whole is constructed for a double track. The pile bents are placed at distances of from 10 to 15 feet apart, and the distance from the floor of the bridge to the surface of the ground, or bottom of the water, varies from 15 to 50 feet.

A draw has been constructed in Back Cove bridge of 35 feet opening, and is designed to accommodate two tracks. It is formed of four light trusses, which are operated by a rack and pinion, the trusses swinging on hinges. The trusses for both tracks move at the same

moment and by the same power, but in opposite directions; and those of each track approach each other in a parallel position as they recede from their bearings in the bridge, till they reach the wings of the draw, where they are folded together in a recess by a movement similar to a parallel rule. The time required to open or shut the draw is less than two minutes, which is done by one man, making six revolutions with a lever of 11 feet length.

The grading of the first and second divisions of the road being nearly completed, I have prepared the following tabular statements, showing the principal items of work, the number of yards per mile, and the average cost per yard. By contrasting these prices with those for similar work on other roads, the stockholders will be enabled to judge of the economy with which their road has thus far been constructed. It must be remembered, that the cuts on nearly the whole line are of hard blue clay, or indurated earth of other descriptions. Common excavation, by our classification, includes ordinary loam, sand, gravel, or any kind of earth which is not indurated, and the average cost of removing this has been but 9 6-10 cents per cubic yard. The whole has been executed at much less cost per yard than any work of similar character within my knowledge.

On other roads, owing to the high prices of provision and labor last year, a great number of contractors failed, their contracts were abandoned, and the work re-let at an advance of from 10 to 15 per cent. on the original prices; while on your road, the whole of the work under contract, with the exception of a comparatively small amount on one section, has been executed at the original prices, and at a cost below the original estimate.

The bridges, with one exception, have been built by contract, the contractors furnishing all the materials and performing the work at a given rate per linear foot of bridge, and these prices are considered low, if reference is had to the character of the work.

These results must be gratifying to the friends of the enterprise, and are evidences of the ability and energy of the contractors.

The total estimated cost of grading and bridging from section No. 1 to 17 inclusive, was	$368,298
The total expenditure for these items on this part of the line, up to the first of July, is	338,620
Showing an excess in the original estimate over expenditures up to that date, of	$29,678

The cost of the work remaining to be done, will fall short of this excess.

Tabular Statement of Grading and Masonry from Sec. No. 1 *to* 17, *inclusive.*

Sections.		GRADING.				MASONRY.			
No.	Length in miles.	Earth excavation Cubic Yards.	Loose Rock Cubic Yards.	Solid Rock Cubic Yards.	Embankment haul.	Protection wall Cubic Yards.	Masonry in culvert cubic yds.	Mas. in B. abutm'ts cubic yds.	
1	2·12	54,341	1,200	10,241	65,782	13,999	185	1,420	
2	0·96	17,140	4,430	454	17,594		436		
3	1·00	39,884		4,213	43,247		651		
4	0·95	96,202			96,202	4,803	472	2,742	
5	1·00	28,446		885	28,050		400		
6	1·00	21,142			19,960		780		
7	0·93	16,235			13,842		461		
8	1·00	14,998		200	12,555		300		
9	1·25	21,145		1,190	16,812		354		
10	1·42	18,125	100	1,686	18,677		432		
11	2·50	32,500			10,000	100	257	1,000	
12	2·35	62,000			55,000		458	2,000	
13	2·40	86,600	100	250	80,000		976		
14	2·48	78,435	614	362	56,400		1,466		
15	1·93	53,000	180	800	53,000		506		
16	2·00	79,642	110	952	79,642	3,972	296	1,393	
17	2·25	77,617	1,737	584	80,000	2,260	605	1,574	
Total Cubic Yards.		797,452	8,471	21,817	746,763	25,134	9,065	10,129	
Average No. of Yards per mile.		28,981	307·6	792·2	27,115	912·6	329·9	367·7	
Average cost per Cubic yard.		$0·145	0·24	0·754	0·033	1·116	2·51	4·295	

Tabular Statement of Bridges from Section No. 1 *to* 17, *inclusive.*

Description and location of Bridges.	Length in Feet.	Average cost pr. ft. of Bridge.	Total cost.	Remarks.
Pile bridge at terminus,	2233	$ 6·80	$15,184·40	Double Track.
" " " Back Cove,	1519	16·45	24,987·55	" "
Truss " Presumpscot R.	320	20·00	6,400·00	How's pat. sing. track.
" bridges Sec. 11 & 12,	264	17·68	4,667·52	" " " "
" " " 16 & 17,	286	13·40	3,832·40	" " " "

II. *Track.*—The track of the road from Portland to Royal's River, a distance of about 11 miles, was placed under contract in February last, and the work has so far advanced as to permit the cars to run to North Yarmouth. The iron and timber required for the balance of the road to Mechanic Falls, an additional distance of 21½ miles, are contracted for, excepting that portion of the timber required between Danville and the latter place. The road may be opened for business to the junction of the Androscoggin and Kennebec Railroad in September next, and the remainder of the distance to Mechanic Falls, in November next.

The track of the road is formed of pine longitudinal sills, 7 by 11 inches square, embedded in gravel, tied together transversely by oak ties 2½ inches thick, and 6 inches wide, fitted into, and even with the surface of the sill, by a dove-tail joint, and secured with keys of the same description of timber.

The iron is of the bridge pattern, weighing 63 lbs. per yard, and is laid with a continuous bearing on the sills, being secured in its position by claw-headed spikes, chairs, and centre plates. The gauge of the road, or the space between the rails, is 5½ feet.

There is half a mile of double track laid at the terminus, also side tracks leading to the engine house and to the works of the Portland Company.

III. *Depot Grounds, Buildings, &c.*—Contracts were entered into early last year, for the construction of crib-work and the requisite earth filling, to provide a site for the buildings at the terminus, and other depot purposes. This work was mostly finished last year.

A portion of the crib-work has somewhat changed its position, in consequence of the great depth of mud, but it is now rendered permanent and secure. The line of the dock is parallel with the road, the approach to it by vessels made more convenient, and the whole is much improved.

In the month of May last, a passenger building and an engine-house at the terminus, and a building for the North Yarmouth station, were placed under contract. The passenger building is 200 feet long and 75 feet wide, and is designed to accommodate, for the present, both the freight and passenger business at the terminus. It is of sufficient width for three tracks, and two platforms of 20 feet width each. The portion now erected is intended, for the present, to accommodate the several trains arriving at and departing from this station; and it is designed, hereafter, to carry out the building with a suitable front, to the east line of India street, which will furnish the requisite rooms for passengers and offices of the Company.

This addition will make the whole length of the building 250 feet, and allow three tracks in it of 220 feet length each. If greater length than this is hereafter required, it may be conveniently obtained by adding to the eastern end of the building. This building stands parallel to the dock and to the line of the road, the track approaching it on a straight line for the distance of half a mile.

It is conveniently situated for the transfer of freight from the cars to

vessels; and passengers going out or arriving in steamboats, have merely to cross a platform between the cars and the boat.

The location of your road is such at the terminus, that it is parallel with the harbor for the distance of half a mile, and for the whole of this distance, vessels have an uninterrupted approach to the road, where they may receive and discharge their cargoes directly from and to the cars. Such are the facilities, at the present time, that vessels now discharge their lading of iron, timber, and other building materials, at any point within this distance, on the main tracks of the road.

The engine-house is of brick, and is only intended to accommodate the requisite number of engines for the business of the first few years, after which it will be useful for the storage and repair of cars. It is of sufficient capacity to contain six engines, and a turning table of 45 feet diameter. A small addition made to the building, at such time as the business of the road requires it, will give ample room for nine engines, and it will still be of convenient shape and an economical building for other purposes, when superseded by an engine house of the requisite dimensions to accommodate the business of the whole road.

The passenger station at North Yarmouth will probably be finished the present month, and the freight business of that place may be accommodated, for the present, by the use of the building purchased with the lands of the Company at that place, which it is proposed to move to the point required for that purpose.

The plans of buildings required for other stations are matured. The drawings and specifications are in progress, and will soon be submitted for the consideration of the Board.

Two turning-tables have been constructed, which are respectively 25 and 45 feet in diameter. The large table is now in use and operates satisfactorily. The small one is designed for the station to which the cars may run during the coming winter.

IV. *Machinery for the Road.*—Two locomotives have been purchased to provide for the immediate necessities of the road. One has been in use on the road a considerable length of time, hauling gravel, timber, iron, &c. The other will be used for the passenger business till other engines are completed, and will also aid in the transportation of building materials.

There have been ordered from the works of the Portland Company, three engines, six passenger cars, two baggage and mail cars, thirty enclosed freight, ten platform, and twenty earth cars. There are now delivered and in use on the road, two passenger, four platform, and eight earth cars. The work on the engines is progressing, and the builders hope to deliver one by the first of September, one in October, and the third in season for the spring business. Two passenger and all the earth and platform cars are to be finished by the first of September, and the remaining passenger, and all the enclosed freight cars by the first of November.

V. *Surveys.*—A careful survey has been made, during the last year, of the whole country between Paris, (the point to which the final location of the road is made,) and the Province line. The total length

of line surveyed is over 150 miles, which includes the survey of several subordinate routes.

A line was traced, during the last autumn and winter, through the Little and Great Androscoggin valleys, the Ammonoosuc valley, and on both the New Hampshire and Vermont side of the Connecticut valley. Surveys were also made for a branch to Lancaster, and to test the practicability of carrying the main line to that place, through the valleys of Moose and Israel's rivers.

There are several routes by which the boundary line may be reached, and all have been instrumentally examined, except that by the Nulhegan valley, the surveys of which are now progressing. These surveys will be completed the present summer, and the results of the whole will then be submitted for the consideration of the Board.

These routes diverge in the Connecticut valley at a point about 22 miles south of the Province line, and again unite near Lenoxville, in Canada, a distance of about 25 miles north of the boundary.

This required that the Provincial corporation should co-operate with you in the survey of these routes, and I am happy to state, that thus far the surveys have advanced in concert, and will be completed on each side of the boundary at about the same time. When the question of junction shall have been definitely settled, the whole route of your road may be regarded as determined.

The disbursements through this department for surveys and construction up to the first of July, were $454,844·90.

In conclusion, permit me to urge the importanceof completing the road and of opening it for business to Mechanic Falls the coming autumn. The grading will be finished at an early date, and it only remains to obtain the timber and lay the track, to bring into use this additional piece of road. Mechanic Falls is an important point, from which roads diverge in every direction, and to which the trade and travel of the surrounding country will naturally concentrate. By extending it to this point, a large additional trade will be secured to the road, which otherwise will pass through other channels to market.

I have the honor to be, Sir, your ob't servant,

A. C. Morton, *Chief Engineer.*

On the Strength of Materials, as applicable to the construction of Cast or Wrought Iron Bridges, including an account of the Tubular Bridges over the Conway and Menai Straits, &c. By George Buchanan, *Esq.*

(Continued from page 4.)

In the first part of this paper, Mr. Buchanan described, on a former evening, the principle and construction of the High Level Bridge at Newcastle, which is intended to complete the communication by railway between London and Berwick-upon-Tweed. Some inquiry having been then made from the chair regarding the bridge over the Tweed, the only remaining link uncompleted between London and Edinburgh, he had received the following particulars from Mr. Harri-

son, the resident engineer under Mr. Stephenson :—This bridge is to be of stone, and is to consist of 28 semicircular arches, each 61½ feet span, resting on lofty piers, carrying the level of the railway 103 feet above high-water mark, 126 feet above low-water mark, and 135 feet above the deepest part of the bed of the river. The whole length of the bridge, with abutments and wing-walls, is 2140 feet. The 28 arches are divided into two series by a broad pier, 28 feet in thickness in the middle. The piers of the arches are 8½ feet in thickness at the springing, increasing by steps towards the bottom. The bridge will not be completed for 16 or 18 months, but it is intended to have a temporary bridge ready for traffic in the month of July next. This viaduct is a work of great magnitude, and will form, when finished, a striking and imposing structure, and one of the many to which the extension of railways has given rise. While on this subject, he would mention two other remarkable works, recently designed and executed by Mr. Miller on the North British and Ayrshire Railways. The one is the viaduct over the Valley of Dunglass, between Dunbar and Berwick, not far from the once-celebrated Pease Bridge. This viaduct crosses the valley and banks by six semicircular arches, each 60 feet span, and then the deep ravine by a single arch, 135 feet span, and rising 105 feet above the bed of the stream. A large and beautiful model of this structure was exhibited, which Mr. Miller, at the President's request, had allowed to be shown to the society. The other viaduct is that of Ballochmyle, across the Water of Ayr, on the Cumnock Extension of the Ayrshire Railway, and is similar to that of Dunglass in crossing the valley on three semicircular arches, each 50 feet span on each side, but is still more remarkable in crossing the deep ravine in the middle by a single semicircular stone arch no less than 180 feet span, and rising 150 feet above the bed of the stream—a bold and noble design, and which has been executed with complete success, the adjacent rocks furnishing such vast blocks of stone as greatly to facilitate the construction, and to render, indeed, the plan itself practicable. The arch stones are 5 ft. 3 in. deep at the springing, and 4 ft. 9 in. at the crown, and the appearance from below of the stupendous arch rising to such a height is singularly grand and striking. The whole arrangements connected with the quarrying and raising and depositing the stones on the building, by the improved machinery of modern times, have been most efficiently conducted by the contractors, Messrs. Ross and Mitchell, and the simple mode of centering adopted and shown in the Dunglass model is recommended by the advantage of preserving the timbers entire.

The subject of stone bridges opens a wide and interesting field, but extending beyond the limits of this paper. He would, therefore, resume the one more immediately prescribed, namely, the strength of materials, particularly iron, for bridges. Some interesting experiments, which the time on the previous evening did not permit to be shown, were then made on the tensile strength of stone from Hailes and Craigleith quarries. The Hailes stone bore on the square inch 360 lbs., the Craigleith considerably more; and a remarkable effect was observed here after the load had hung for a little: it was suggested by a mem-

ber to give it a slight tap with a hammer, and, on this being done, it immediately snapped asunder, showing the effect of vibration or concussion when the materials are greatly strained in aiding and completing the fracture, a circumstance which appears to throw light on what may sometimes occur by the rapid and violent actions of the trains on railways. The compressive strength of the Hailes and Craigleith stones was then shown, by experiment, to be much greater than the tensile strength; and as it required, indeed, more weight and a more powerful apparatus than could be commanded, these experiments on different stones were deferred to another evening.

The compressive strength on posts or pillars was then considered, and the remarkable effects of the length of the pillar in diminishing its strength. On this subject much light has been thrown by the experiments of Messrs. Hodgkinson and Fairbairn. Pillars or rods were tried of different lengths, from 3 inches to 5 feet, and of different diameters; rods half an inch diameter, with 3¾ inches length, bore 11 tons; but when the length was 7½ inches it only carried 5 tons; when 15 inches long, 3 tons; and at 30 inches only 13 cwt. From these experiments, a general rule may be drawn for different lengths. Taking the strength of cast-iron as formerly given at 50 tons per square inch, this will hold good in pillars till the length reaches five times the diameter, and then it begins to diminish. When the length is ten times the diameter, the strength is reduced in the proportion of 1¾ to 1; with the length at 15 times the diameter, it is reduced as 2 to 1; 20 times as 3 to 1; and 40 times as 6 to 1.

Hence the great advantage in cast-iron, of using hollow pillars or tubes in place of solid metal, whereby, with the same area or section of fracture, the diameter of the pillar is increased, and with it the resistance to flexure, and an increase of strength in proportion to the length. A solid pillar, for instance, 6 inches in diameter, if extended to 7½ feet in length, would be weakened one-half, but if cast hollow, 10 inches in diameter, and ¾ inch thick, giving the same weight of metal per foot in length, it might then be extended to 12½ feet, and still possess the same strength as the other. In all these cases a remarkable circumstance was observed in regard to the mode of applying the strain. With the ends of the pillar turned flat, and a flat plate interposed at top and bottom, which is the case in supporting buildings, this was found to sustain nearly three times as much as when the pillar was rounded on the ends, so as to make the force pass directly through the axis, as occurs so frequently in machinery with the connecting rods of steam-engines, and in other cases. The effect of the length of pillars in weakening the strength, was illustrated by a striking experiment with a spiral wire, quite flexible, yet, when set up as a pillar, and tied in the middle laterally, with slender threads, carried a weight of 56 lbs., and would have carried much more, but the moment the threads were cut, the wire gave way by flexure, and oversetting the balance, the weight immediately sunk.

In regard to the transverse strain, he had already explained the nature of this compound action, and particularly the manner in which, under it, the beam becomes exposed at once to the effects of tension

and compression, the one side being distended and the other compressed. On this most interesting and important subject he had still much to say, but would defer it to another evening, as the time was short, and he was anxious to proceed with another part of the paper which had been particularly referred to, namely, the subject of the tubular bridges.

The application of malleable iron had been already used in the shape of tension-rods in cast-iron girders, and was applied, as we have seen, in the high level bridge at Newcastle; but the application of girders constructed of malleable iron alone is a new idea. It has been applied on railways in the case of skew bridges of wide opening and limited depth between the railway and the road; in these cases the girder consists of a rectangular hollow tube, or square box, extending over the whole span, and of such depth as can be attained. These have hence received the name of Tubular Bridges, and have excited much attention since the grand experiment has been determined on, of trying these structures on such a magnificent scale as is now in progress of execution in the crossing of the Straits of Menai by the Britannia Bridge, and the estuary of the Conway by the Conway Bridge, and which form, without doubt, the most remarkable engineering enterprises of the present day. These spots, as is well known, had already been the scenes of vast engineering operations connected with the suspension bridges of Telford, to form the great turnpike road communication from the metropolis to Holyhead, and thence across the channel to Dublin; and when it was determined that this communication should be superseded by railway, it became a matter of most serious consideration how these two openings were to be spanned, keeping in view the new conditions of stability required for railway traffic; and the subject having been submitted to Mr. Stephenson, the engineer of the line of railway, namely, the Chester and Holyhead, he at once rejected the principle of the suspension bridge as inapplicable, owing to the undulations to which it was liable, and which had been proved by practice in a similar bridge for a railway across the Tees, to be both inconvenient and dangerous. How far the principle might have been modified by the introduction of proper ties and braces may be a question; but in a case of such vast magnitude and importance there might still have been risk, and, on the maturest consideration, Mr. Stephenson determined to recommend the simple and bold design of a hollow rectangular tube of malleable iron, consisting of thin plates rivetted together, such as he had already tried with success on a smaller scale upon railway bridges, and which he conceived was the best form for securing not only strength, but sufficient stability and stiffness to prevent any undue oscillations or vibrations. To carry out this plan, the assistance of the first authorities, scientific and practical, on the strength of materials, was called in, and to Messrs. Hodgkinson and Fairbairn the duty was submitted of trying the effect with experimental tubes on a small scale, and finally on a model one-sixth of the dimensions of the bridge, being 75 feet long. Much valuable information was obtained during the progress of these experiments. The first thing observed was the uniform tension of the under side of the tube when

loaded, and the violent compression of the upper side, forming a beautiful illustration of the nature of the tensile and compressive forces already laid down. The former, by its uniform tendency to produce the stable equilibrium, bringing the thin masses into a straight line, the line and position of repose; but the latter, on the contrary, tending to produce flexure in the plates, to push them out of the straight line, and push everything out of joint; so that when the bottom plates remained firm, and retained their form, the top plates became bagged up and puckered like a loose web of cloth. The top plates were, therefore, strengthened, and the addition of another plate to the top increased the breaking weight from 3,700 lbs. to 4,500 lbs.

As it was not so much strength that was wanted on the top plate as stiffness, in place of adding layer upon layer of plates, the idea naturally occurred of forming the top plate into a series of little hollow square tubes running longitudinally the whole length of the bridge, having the appearance, looking endways, of little cells, the effect of which was such, that while the top plates remained firm, the bottom ones now appeared to give way. These being next strengthened, an extraordinary effect was then exhibited when the tube broke, the sides collapsing together, and twisting and distorting the whole fabric in a singular manner, showing that the sides formed now the weak point. These, then, were strengthened and stiffened by numerous ribs of angle-iron running vertically from top to bottom, and at last, by these repeated trials, the strength and proportions of the different parts of the structure appeared to have attained a fair and proper distribution. The strength of the tube, which at first only carried seven times its own weight, was then increased to eleven times, and from these experiments, the strength and proportions of the real design have been calculated, and one of these tubes, as is known, has now been actually constructed on the shore of the Conway, floated by water to its place, and raised to its proper height by the power of two enormous hydraulic rams, one at each end, lifting the gigantic mass, which is 412 feet in length, 15 feet wide, 25½ feet high, and weighing no less than 1300 tons. This is intended for one set of rails, and there is another tube of the same dimensions in preparation to be set parallel to it for the other.

The situation of the structure close to the suspension bridge, and close to the base of the magnificent Castle of Conway, and the effect of spanning the wide estuary of the Conway, were all illustrated by a beautiful drawing, and the nature and construction of the tube or bridge itself, was illustrated by a model which he had himself constructed. The model was composed of only three thicknesses of paper and one of cloth, and the sides were strengthened by thin slips of wood to represent the angle-iron; it was 8 ft. 6 in. long, 6¼ inches deep, and 3½ broad, and although weighing only 4 lbs. it carried a weight of 32 lbs. in the centre, without visible deflection.

The dimensions and structure of the bridge he would now describe, from information for which he was indebted to Mr. Fairbairn of Manchester, and, through Mr. Stephenson, to Mr. Edward Clarke, the resident engineer under him.

The sides of the tube, which are 25½ feet deep at the centre, consist of

malleable iron plates, only ½ inch in thickness, rivetted together in plates 2 feet broad and from 4 to 8 feet long, (as was shown in an enlarged view or elevation with cross sections,) adjusted so as that the joints may break band. At the joints, however, the strength and stiffness of these plates is greatly increased by slips of angle or T iron, one of which is laid on the outside of the plate, and the other opposite to it on the inside, face to face, and all the four surfaces strongly rivetted together. The top of the tube, again, consists of two separate horizontal plates, running parallel to one another, 1 ft. 9 in. apart, forming together as it were a ceiling to the tube or tunnel, and an external flooring on the top. These plates are ¾ inch thick, rivetted together in breadths of 2 ft. 9 in. thick, and in lengths of 6 feet, and between them there runs seven vertical plates longitudinally, from end to end of the bridge, 1 ft. 9 in. high and ¾ inch thick, separating the ceiling from the floor or upper platform, and at the same time uniting them strongly together by rivets and joints, each vertical plate having a rib of angle-iron on each angle, running longitudinally the whole length, by which it is united into one vast cellular mass, consisting of eight separate cells or tubes, 1 ft. 9 in. square. The object of all this strength and distribution of materials is to give the necessary stiffness and strength where the compressive force acts. And on this account the top and bottom plates are merely united by butt joints with covering plates. The whole sectional area of this cellular frame consists of 608 square inches. Lastly, the bottom of the tube consists of a similar frame of cells, but only six in number. The upper plate consists of two layers of plates, each ½ inch thick, and the under one the same; but as these plates are intended to resist tension, and ought to be formed, if it were possible, like a chain, besides being laid in two layers, the plates are arranged so as to break joint, and a covering plate 3 feet long and as thick as the plate, is placed over every joint with sufficient rivets, such that the tearing strain is equal to the tensile strength of the plates they connect. The plates are 12 feet long and 2 ft. 4 in. broad, being the whole breadth of the cell. The angle iron in the bottom cells and plates is rendered continuous by covers.

The top and bottom are united to the cells by strips of angle-iron running the whole length, inside and out; the interior vertical angle-irons at the top and bottom are curved round to increase the strength of attachment, and there are also gusset or angle pieces rivetted on for additional strength. The rivets used vary from 1 inch to 1¼ inch diameter, and there are about a quarter of a million in each tube. The holes were made so as to make the rivets fit well, and they were all put in red hot. The sectional area of the bottom frame of cells is 508 square inches.

These are the dimensions in the centre of the tube, but the top plates become thinner towards the ends, where they are only ½-inch thick, and also the bottom plates, where they are reduced to ¾-inch each. The side plates again get thicker towards the ends, where they are $\frac{10}{16}$ths thick. The ends of the tube are stiffened with cast-iron frames, and there are also castings in the cells for 8 feet at the ends, and the sides are also greatly strengthened at the ends. The tube was origi-

nally curved on the top 7 inches, and was brought to the straight line by the elasticity of the material as calculated on; showing that with its own weight, 1300 tons, it only sunk 7 inches. The one end of the tube is to be fast in the stone pier or abutment, the other is to be loose to allow of expansion, which has been found quite visible in different states of the atmosphere. Mr. Clarke says that the tube is a sensible thermometer,—half an hour's sunshine at one end, or on the top, will move it laterally an inch and a half, and vertically two inches, and this when the tube is loaded with 200 tons in the centre.

Such are the dimensions and structure of this extraordinary work, and in regard to which, he was happy to say, the trials which have been already made appear to promise every success. A load of 100 tons only sunk the tube 1 inch in the centre. In regard to the calculation of strength he was not able to enter on these at present for want of some of the data, but expected to do so on a future occasion.

The thanks of the Society were voted to Mr. Buchanan for his excellent and instructive exposition; and also to Mr. Stephenson, Mr. Fairbairn, Mr. Clarke, and Mr. Harrison, civil engineers, for communicating the information relative to the tubular bridges at Conway and Menai, and viaduct at Berwick; and to Mr. Miller, C.E., for allowing his elegant model of the viaduct at Dunglass to be exhibited. Mr. Buchanan was at the same time requested to continue his observations, and lay them before the Society at a future time, which request he kindly promised to comply with.—*Proc. Roy. Scot. Soc. of Arts.*

Civ. Eng. & Arch. Journ.

Fares Charged on several of the Railways in England, per Passenger per mile.

We copy from the report lately published, the fares actually charged by a few of the railways per passenger per mile:

	1st Class. d.	2nd Class. d.	3rd Class. d.
Bristol and Birmingham,	2·64	1·75	·94
Eastern Counties,	2·30 1·91	1·53 1·30	·97 ·79
Great Western,	2·74	1·88	
London and North-Western,	2·18	1·45	·91
London and Brighton,	2·63	1·71	1·18
London and South-Western,	2·87 2·03	1·89 1·43	·96
Midland,	3·	2·	1.00
South-Eastern,	2·29 2·	1·54 1·25	·90 1·00
York and North Midland,	2·25	1·75	1·25

Lond. Rail. Journ.

Description of Cars for Conveying Gunpowder on Railways.

It may not be generally known that large quantities of gunpowder

are frequently and safely conveyed by railway, as much as eleven tons in one day, and in the course of a few months above one hundred tons of gunpowder have been carried on the London and North-Western line to Liverpool, Manchester, Leeds, and other places. The wagons in which the gunpowder is conveyed are made expressly for the purpose. There are eight of these wagons on the London and North-Western railway, constructed in accordance with the patent of Mr. Henson. The body of the wagon is formed with sheet iron on the outside; the inside is lined with two-inch plank, between which and the iron outside a thickness of felt is carefully placed. These are screwed together from the outside, so that there is nothing but wood inside; except on the floor, which is covered with sheet lead. The door fits so close with a double rabet, that it is almost air tight, and it is therefore imposible for any fire to get to the powder inside the wagon.

The axles are cased with wood. The comparative absence of the usual noise and vibration in the movement of these powder-wagons, is very remarkable. Ibid.

AMERICAN PATENTS.

List of American Patents which issued in the month of June, 1847, *with Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

1. For an *Improvement in Threshing and Cleaning Wheat, &c.;* Samuel Barley, Keers Creek, Rockbridge county, Virginia, June 5.

Claim.—"What I claim as new, and desire to secure by letters patent, is, first, the manner in which I construct the shaker, by forming its bottom of fluted boards, and of rollers turning upon pivots, substantially in the manner, and for the purposes set forth; and secondly, I claim the particular manner in which I have arranged and combined the two fan wheels, and the two vibrating boxes, or shoes, operated by means of the vibrating bars, and otherwise constructed and actuated in the manner described."

2. For an *Improvement in Manufacturing Skates;* B. F. Shellabarger, Mifflintown, Juniata county, Pennsylvania, June 5.

The patentee says,—"The nature of my invention consists in casting solid with the runner of a skate, three thin plates for the heel, ball, and toe of the foot to rest upon, and also eyes or loops to attach the straps to for fastening the skate to the foot."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the casting the plates for the foot to rest upon, and the bars to attach the straps to, all solid with the runner, respectively arranged and proportioned substantially as herein set forth."

3. For an *Improvement in Making Candles;* B. F. Shellabarger, Mifflintown, Juniata county, Pennsylvania, June 5.

Claim.—"What I claim as my invention, and desire to secure by

letters patent, is the manner in which I form the candles, point them, and cut them to a suitable length at one operation, by means of the cylinder, piston, wick tube, moulding tube, grooved pulley, axles, and connecting band; the cutter wheel, curved cutter, and conical spiral cutter, combined and operating with each other substantially as herein set forth.

"I also claim the manner of preparing the tallow, or other suitable material for moulding in a cold state, by cutting it into thin slices, previous to placing it in the cylinder, for the purpose of giving equal solidity to the candles, and uniformity of appearance."

---

4. For an *Improvement in Smelting Copper Ores;* James Napier, Stockwell, Middlesex county, England, June 5.

Claim.—"What I claim is the application of iron with alkaline substances to the smelting of copper ores, and the decomposing, and disintegrating, by means of water, the product obtained by such application."

---

5. For an *Improvement in Fire Arms;* Henry S. North, Middletown, Middlesex county, Connecticut, June 5.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the guard lever with the crotch, by means of the notch in the guard-lever, made back from its axis, and near where the curve of the bow commences, when in combination with the receiver, or magazine, by means of the stud, or finger on the guard-lever, and mortise on the under side of the receiver, or magazine, the whole combined and operating substantially as hereinbefore described."

---

6. For an *Improvement in Rotary Steam Engines;* James Black, Philadelphia, Pennsylvania, June 5.

The patentee says,—"The nature of my invention consists in the constructing a steam wheel with a double series of curved buckets, secured to its periphery, closed at their sides, and divided by a central division plate, with the spaces between the series of buckets on each side of the division plate, connected by curved apertures; and the arranging the steam wheel within an enclosing casing, in such a manner, that steam admitted to the buckets on one side of the central division plate, will act directly upon the wheel, by impinging upon the face of the buckets, and descending to the base of the same, will pass through the connecting apertures to the series of buckets on the opposite side of the division plate, and in escaping from between which, it will react upon the face of the buckets, and give additional impetus to the wheel."

Claim.—"What I claim as new, and desire to secure by letters patent, is the double series of curved buckets upon the steam wheel, with the spaces between the same, united as herein described, combined with the steam pipe, by means of the segment, substantially in the manner and for the purpose herein set forth."

7. For an *Improvement in Grinding Mills;* Asa Barber, Stephentown, Rennsselaer county, New York, June 5.

The patentee says,—"The nature of my invention consists mainly in the application of two metallic furrowed surfaces, for the purposes of grinding grains of wheat, corn, coffee, barks, drugs, &c.; being combined in such a way as to dispense with all the ordinary grinding stones now in use."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the conical drum, and lifters, with the grinding cylinder, and concave furrowed bed, substantially as herein described and set forth."

---

8. For an *Improvement in Water Wheels;* Uriah A. Boyden, Boston, Massachusetts, June 5.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is—

"Firstly, Fastening conical or bell-shaped rings to the circumference, or outer edges of the rings, or rims of turbine wheels, and reacting water wheels, which the floats are attached to, or making the rings or rims which the floats are attached to, of so large a diameter as to extend outward beyond the outer extremities of the floats, or buckets, and making the part of one or of both of the rings or rims which are outside of the floats, curved, conical, bell-shaped, or such other form, that the distance between them at their exterior edges, or circumferences, shall be greater than at their parts next the outer extremities of the floats, as described above. I do not limit my claim exactly to the width or forms described, but extend it to all forms which are essentially the same as those described. I do not include in this claim the placing bell-shaped rings, around the circumferences of wheels, detached and separate from the wheels; but I claim these adjuncts so attached to the wheels as to revolve with the wheels, or so made as to be parts of the wheels.

"Secondly, Making the parts of the tops of the leading curves at and near the garniture sloping; though I do not confine my claim exactly to the angle of slope described, but extend it to all slopes of any angle, inclination, curvature, and extent, which will in any degree, answer the same purpose."

---

9. For an *Improvement in Raising Ice from Ponds, &c.;* Willis M. Cowling, Richmond, Henrico county, Virginia, June 5.

The patentee says,—"The nature of my invention consists in the employment of an inclined endless belt, or chain of slats that passes around two rollers, one placed below the surface of the water, and the other as high as it is desired to raise the blocks of ice; the slats being provided with sharp metal pins, or points, that stick into the blocks of ice, and hold on to them sufficiently to carry them up the inclined plane, and deliver them at top by the passing of the belt around the upper roller."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the method of elevating blocks of ice from the water, by means of an endless belt, or chain, provided with sharp metallic points, substantially as described."

---

10. For an *Improvement in Fire Arms;* Edwin Wesson, Northborough, Worcester county, Massachusetts, June 5.

The patentee says,—"The object of my improvement is to discharge two or more gun barrels, (having separate charges,) at one and the same time."

Claim.—"What I claim as my invention, is the afore-described improved mode of combining and connecting several guns, or barrels, so as to cause their charges to be fired by the explosion of the charge in one of them, substantially as herein set forth."

---

11. For an *Improvement in Snubbing Canal Boats, and Vessels;* Joseph Rowland, Hancock, Washington county, Maryland, June 5.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the attaching to a canal boat, and barge, movable fenders, as herein described, in combination with the arms, levers, ropes, and uprights, as herein described."

---

12. For an *Improvement in Excavators, or Ploughs;* Henry B. Sommers, Greenfield, La Grange county, Indiana, June 5.

Claim.—"What I claim is,—1st. The above named toothed roller, in combination with the shares, operating in the manner and for the purpose described.

"I also claim the forward cutter, in combination with the wheel, and shares, for levelling the bogs, or turf, in the manner described. I also claim the vertical cutters, in combination with the shares, for separating the furrow from the land border, as described."

---

13. For an *Improvement in Cutting Files;* Richard Walker, Portsmouth, Rockingham county, New Hampshire, June 12.

The patentee says,—"The nature of my invention consists in constructing a machine to cut two sides of a file at the same time, and by one and the same motion, by pressure on the chisels, instead of a blow by a hammer, the power of pressure being a suspended weight, arranged in such a manner, as to give any required depth of cut in a more regular and uniform way than by a blow, or otherwise."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the weight, cam, slide, and dog, with the carriage, toggle joint, and cutter levers, for the purpose of cutting files by pressure, substantially as herein set forth."

---

14. For an *Improvement in Sash Machinery;* Jesse Leavens, Springfield, Hampden county, Massachusetts, June 12.

Claim.—"What I claim as new, and desire to secure by letters pat-

ent, is,—1st, The employment of small cutter heads, placed on separate shafts at right angles to the stuff to be tenoned, which enables them to cut with the grain, and also to cut under at the shoulder, and be readily adjustable, the space between the cutters being left free for the tenon to pass through, as set forth, so that by passing the stuff once through, it is tenoned, coped, and franked at one operation, as specified.

"Secondly, I claim the combination of a treadle, with the rotary power, of a mortising machine, to gauge the depth to which the chisels cut, and to tighten the band gradually as the chisels cut deeper, so that the chisels can be gauged, and driven at any elevation within the compass of the machine, by the bands connected with the eccentric shaft, as set forth, and at the same time can be readily worked by manual power, if required.

"Thirdly, I claim constructing the cutter iron in the manner set forth, in two or more parts, having all the cutting edges in the same plane, so that they can be readily separated and sharpened, when made in the most complex figure, and then re-combined in a permanent manner, as set forth."

---

15. For an *Improvement in Composition for Currying Leather;* Isaac H. Hershey, Hagerstown, Washington co., Maryland, June 12.

The patentee says,—"To make and prepare the composition, or stuff, to be used on leather, instead of 'dubbing,' I use common rosin, gum asphaltine, common hard soap, tanners' oil, and stale urine, preparation as follows:

"Half pound gum asphaltine, pulverize and mix the rosin and gum asphaltine, and put them into two gallons of good tanners' oil; then take one pound common hard soap, cut fine and put into the oil; then place the whole as mixed, over a slow fire, or heat, stirring occasionally, until the soap is fully melted, or dissolved; let stand awhile until pretty well settled, then pour off carefully, so that the sediment, if any, may remain in the vessel; while warm, add one gallon stale urine, stir well, and when cool it is ready for use."

Claim.—"What I claim as my invention and discovery, and desire to secure by letters patent, is the use of rosin, gum asphaltine, and hard soap, mixed and combined with oil and stale urine, for the purpose and use above stated."

---

16. For an *Improvement in Fire Alarms;* D. Tomlinson, and H. S. Hopkins, Brookfield, Fairfield county, Connecticut, June 12.

The patentees say,—"The nature of our invention consists in the putting in action an alarm, similar to that of the common alarm clock, or any other alarm, to give notice of danger, by means of the expansibility of metallic wire passing through the place to be guarded, and connected with said alarm in case of fire, and producing the same effect, by opening the door, or by other movement, within the place to be guarded, by means of a wire, or cord, extending to, and connected

with, the said alarm in case of burglary. The same improvement may be applied to the ringing a large bell, or any other means of giving alarm."

Claim.—"We do not claim as our invention combining levers, cords, weights, and pulleys, with a verge wheel, and bell, to give an alarm, as this has been done in a certain manner. But what we do claim as our invention, and desire to secure by letters patent, is the particular manner of combining and arranging the lever, bar, sword, right angled weighted lever, perforated plate, with the metallic rod, or wire, attached to the said right angled weighted lever, and a fixed object, kept in a state of tension by said weighted lever, and caused to operate on the sword by a change of temperature, disengaging the bar from the lever, and thus causing the verge to vibrate, and the hammer to operate on the bell, by the action of the weight, and verge wheel."

---

17. For an *Improvement in Boilers for Culinary Purposes;* James Stafford, Cleaveland, Ohio, June 12.

The patentee says,—"The nature of my invention consists in applying a tube, or tubes to culinary vessels, for the purpose of carrying off the steam or gases downwards into the stove, grate, or range, on which they may be placed, and casting on, or otherwise affixing to either or opposite side, where exposed to the action of heat of said culinary vessels, evaporators or pans, numerous solid projections for the purpose of absorbing and radiating the heat."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application of a metallic tube, or tubes, on either side of, or within the body of pots, kettles, steamers, or other culinary vessels, when such tube or tubes shall be used, or intended to be used, for the purpose of conducting off the steam or gases generated within said culinary vessels, *downwards into the stove, grate, or range*, on which they may be placed."

---

18. For an *Improvement in Cooking Stoves;* J. M. Thatcher, Danville, Columbia county, Pennsylvania, June 12.

The patentee says,—"The nature of my improvement consists in so arranging the parts of a stove, as to cause the air which supplies the combustion in the fire chamber to pass through a cooking chamber, on its way to the underside of the grate; the back of the said cooking and heating chamber being the front plate of the fire chamber, and the draught which passes around to heat the oven, being made to pass over the top plate of the said heating and cooking chamber."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the employment, in combination with the fire chamber, of a chamber of sufficient capacity for baking, roasting, or other culinary operation, through which the air to supply the combustion in the fire chamber must pass to be heated, substantially as herein described. And I also claim the arrangement of the air-heating chamber in front of the fire chamber, and on top of the oven, substantially as

described, whereby the top of the oven is prevented from being overheated, and the air-heating chamber can be employed for roasting, baking, &c., as described."

---

19. For an *Improvement in Engraving Bank Notes;* Benjamin Chambers, Washington, District of Columbia, June 12.

The patentee says,—"The nature of my invention consists in covering a plate with parallel lines of words instead of plain lines, as is done in the ruling machines, but instead of making the lines of words commence regularly, I cause the rollet containing the word or words to turn freely and at random, so as to bring any one of the letters of the word promiscuously to the beginning of the line, so that when a succession of these lines is made close together, the impression from the plate on which they are made has an irregular wavy appearance, caused by the lines commencing with any letter that may accidentally be next the plate."

Claim.—"What I claim as new, and desire to secure by letters patent, is producing lines of characters of any description in an irregular juxtaposition, upon metal plates used for printing, substantially as described, by means of a circular die or rollet turning freely on its axis, so as to commence each line at any part of its circumference that may chance to be next the plate."

---

20. For an *Improvement in the Fruit Gatherer;* Peter Collyer, Hunter, Greene county, New York, June 12.

The patentee says,—"The nature of my invention consists in providing a quantity of coarse muslin, or canvass, or rating, constructed in such a manner as when completed, will form one sheet, of which the diameter will be twenty six feet, and the circumference eighty-one feet three inches, when used with the middle or centre part raised to a level with the outside edges, thus forming a bag-like or hollow position, for its purpose of gathering fruit."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the mode described of constructing a new fruit gatherer, for apples and other fruit growing on trees."

---

21. For an *Improvement in Machinery for making Cop Tubes;* Nathaniel Whitmore, Lynn, Essex county, Massachusetts, June 12.

Claim.—"I claim the bending dies in combination with the spindle, and the cutting dies or mechanism, as arranged and operating substantially as described.

"I also claim the supporting slides or bars, in combination with the bending dies, lip dies, and spindle, the same being arranged and made to operate substantially as described.

"I also claim an automatic combination of a feeding apparatus, cutting dies, bending and breading or lip dies, and spindle, either with or without the supporting slides, or with or without the expelling appa-

ratus or finger, the whole being arranged and made to operate together, in the manner and for the purpose substantially as above specified."

---

22. For an *Improvement in Air Tight Stoves;* Samuel B. Sexton, Baltimore, Maryland, June 19.

The patentee says,—"The nature of my invention consists in a certain new and useful combination of a ventilator, in connexion with a register, united by a rod in such a manner, that when the register is closed, the ventilator is opened in the same proportion."

Claim.—"What I claim as my invention and improvement, and desire to secure by letters patent, is the manner of combining the ventilator with the register, by means of the vibrating connecting rod or lever inserted into the loops, and turning on the central pivot, for the purposes above stated."

---

23. For an *Improvement in Cutting Fodder;* John Elgar, Baltimore, Maryland, June 19.

The patentee says,—"The nature of my invention consists in abrading the ends of the fodder before they are cut off, instead of first cutting off the fodder, and then grinding it, as is done in the machine now in use."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is preparing corn fodder for food for cattle by the employment of lacerators in the manner described for abrading the fodder, while held by feeding apparatus, and before the action of the knife, as described; and in combination therewith the knives for cutting it off after it has been lacerated, substantially as described."

---

24. For an *Improvement in Shaft Tugs for Harness;* Joel L. Hoyt, Deer Park, Orange county, New York, June 19.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is an improved shaft tug for single harness which will be more durable and safe, as herein described, using for that purpose any metallic substance or compound which will produce the requisite safety and durability."

---

25. For an *Improvement in Cotton Wadding;* Charles Lewis Fleischmann, Washington, District of Columbia, June 19.

The patentee says,—"The nature of my invention consists in having threads, cords, or loose webs, inserted in the surfaces or through the middle of the batting before it is sized, in such a manner that the fibres which are on the surface of the batting become entangled in the threads, cords, or loose webs, and form, when sized and dried, a well combined and strong fabric."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is incorporating with glazed cotton batting, cords,

threads, or loose webs, upon its surface, or inside, as substantially described.

"I also claim the method of glazing cotton batting by wetting the surface with water or any other thin fluid, as described, preparatory to applying the glazing matter, as described.

"And finally, I claim the method of making thick glazed cotton batting, by splitting a thin cotton batting, glazed on both sides, or the equivalent substitute therefor, and interposing between the two halves of such glazed sheets, any desired thickness of cotton batting, or other materials, as substantially herein described."

---

26. For an *Improvement in Steering Vessels;* Anthony Shermer, Philadelphia, Pennsylvania, June 19.

The patentee says,—"The nature of this invention and improvement consists in so connecting the bow and stern rudders by means of chains, rods, ropes, or other suitable connecting links, crossed and attached to arms, tillers, or levers, inserted into the rudder heads, or to the peripheries of wheels affixed thereto, so that when the stern rudder is turned towards either side of the vessel, the bow rudder will be caused to turn simultaneously to the same side and at the same angle with the line of the kelson—the action or resistance of the water against one of the rudders in its angular position being counterbalanced by the pressure of the water against the surface of the other rudder—the force or pressure of the water being transmitted from one rudder to the other, by the connecting links, arms, or levers aforesaid; by which mode of connecting the rudders, a perfect equilibrium or balance of forces will be produced—the balancing or turning point of the vessel being equi-distant between the rudders, when the rudders are of the same area, or size; rendering the management of the rudders quite easy in comparison with the old mode of disconnected rudders; and putting it in the power of the helmsman to control the direction of the vessel, when accidentally driven stormwise, in which case it is well known that it becomes very difficult to change the position of the rudder, as ordinarily arranged and operated."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is connecting the bow and stern rudders of vessels by an endless chain, or by separate chains, crossed between the rudders, so that by turning one rudder in one direction, the other rudder will be caused to turn simultaneously towards the same side of the vessel, forming the same angle with the vertical longitudinal plane as above described, for producing the effect herein stated; whether the chains be arranged in the particular manner above stated, or in any which is substantially the same, and by which analogous results are produced."

---

27. For an *Improvement in Spark Arresters;* James A. Cutting and George Butterfield, Boston, Suffolk county, Massachusetts, June 19.

Claim.—"What we claim as our invention, and desire to secure by

letters patent, is the double extinguishing cap, placed over the chimney, combined and operating with the cylinder, conical thimble, lining, wells, and pipes, substantially in the manner and for the purpose herein set forth."

---

28. For an *Improvement in Musical Instruments;* U. C. and Charles F. Hill, City of New York, June 19.

Claim.—"What we claim, and wish to secure by letters patent, is, first, combining in musical instruments, cells, or chambers, (open at one or both ends,) with strings, or reeds, or springs, or tuning forks, substantially upon the principles and for the purposes above set forth.

"We claim also the manner of sustaining or suspending the forks used for the high notes, as described. We also claim using hard points upon the hammers used to strike the high notes.

"We also claim the employment of metallic springs, of the character described, in conjunction with tuning forks, in a musical instrument, substantially in the manner described. We also claim the employment of a rack, intervening between the sounding board and said metallic springs. We also claim the peculiar mode of constructing the forks for the high notes, giving them such relative proportions in the shaft (or stem) and prongs, as to bring out the sounds, all in the manner described."

---

29. For an *Improvement in Tanning Morocco;* Lewis C. England, City of New York, June 19.

The patentee says,—"The nature of my invention consists in the continuous application of heat, by fire or steam, to a tanning tub of a certain construction hereinafter described, and to the tanning liquor while in the tub, so as to keep the tanning liquor at the necessary and proper temperature, while the hides or skins and liquor are together in the tub, and in applying to the tanning tub a dasher, to keep the hides or skins in motion or circulation in the liquor, while the heat is applied to the tub or liquor."

Claim.—"What I claim as new, and desire to secure by letters patent, is the manner of arranging and employing the dasher, so as to operate on the surface of the tanning liquor, and thereby to keep up gentle circulation thereof, for the purpose set forth."

---

30. For an *Improvement in Harness Buckles;* Abel B. Bull, Westmoreland, Oneida county, New York, June 19.

The patentee says,—"The nature of my invention consists in combining with the metallic frame, attached to the hame, a jointed lever tongue in such a manner, that as the draft is applied to the trace, it presses against a cross bar of the jointed tongue, and causes the rear end to move *inward* and the forward end to move *outward*, and to act as a lever in regard to the position or the tongue, so as to hold it firmly in position in the aperture of the trace—the tongue being susceptible of disengagement from the trace in an instant, by simply re-

versing the movement of the rear end of the lever, in order to shorten or lengthen the traces, or alter the position of whatever article it is applied to."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the manner of constructing the buckle fastening—that is to say, making the rear end of the buckle in such manner, with reference to the position of the tongue, as will hold the tongue firmly in position by the leverage of said rear end, the parts being constructed and arranged in the manner described."

---

31. For an *Improvement in Measuring Cloth, &c.;* Addison Smith, Perrysburg, Wood county, Ohio, June 19.

The patentee says,—"The nature of my invention consists in applying a thumb piece on a level with the counter on which the yard or other measure is marked at the end of said measure, so that as the thumb piece is depressed every time a yard is measured, it moves a hand with which it is connected by proper gearing around the face of a dial, indexed so as to show the number of yards measured."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the employment of a movable thumb piece at the end of a long measure, substantially as described, connected by proper machinery, with a movable index, so as to register the lengths measured."

---

32. For an *Improvement in Ploughs;* James Walker, Belle Fountain, Logan county, Ohio, June 19.

The patentee says,—"The nature of my invention consists in the method of widening the plough by moving the heel of the mould board, and bracing it by a bolt through the plate share, so that when it is new laid it can be carried out, and as it wears away, it can be gradually contracted, thus presenting the best possible combination of parts during the whole wear of the plough, and also affording greater facility for taking a wider or narrower furrow."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the mould board with the land side and plate share, substantially in the manner and for the purpose set forth, so that the plough can be made wider or narrower at pleasure."

---

33. For an *Improvement in Cutting Straw;* William Lewis, Edgefield Court House, South Carolina, June 19.

The patentee says,—"The nature of my invention consists in placing the knives upon the driving wheel in an oblique position to the axle thereof, and the combining the same with the rest and feeding rollers, placed at such an angle with the straw box, as to give to the knives an oblique drawing cut across the fibres of the straw."

Claim.—"What I claim as new, and desire to secure by letters pat-

ent, is the securing the knives upon the driving wheel in an oblique position to the axle thereof, and combining the same with the oblique rest and feeding rollers, for the purpose of giving a drawing longitudinal cut upon the straw, substantially as herein set forth."

---

34. For an *Improvement in Forming Brick;* C. H. Preston, City of New York, June 19.

The patentee says,—"My improvements consist in making bricks in two, three, or more parts, set and burned together in such a manner as to result in producing indentations and projections that alternately interlock and counterlock into each other, so as to furnish a continuous bonding of the one, two, or more projecting parts of each brick so made into the corresponding indentations of the next bricks, for which improvement I seek letters patent."

Claim.—"What I claim as new and of my own invention, and desire to secure by letters patent, is the making and burning solid bricks, of two, three, or more parts, so placed together as to interlock and form bonding when put in use, substantially in the form described."

---

35. For an *Improvement in the process of making Photographic Pictures and Portraits;* W. H. F. Talbot, England, June 26.

Claim.—"I claim as my own invention and discovery, First, the preparation of iodized paper, as above described, which is not itself sensitive to light, but serves as the basis of all the subsequent operations. Secondly, the employment of gallic acid, in conjunction with iodine and the salts of silver, to render paper extremely sensitive to light. The gallic acid not having been used in photography, previously to my discovery. Thirdly, it was not known previous to my discovery thereof, that paper would be impressed with a latent or invisible photographic image. I claim this as my own discovery, and likewise the means of rendering the image visible at pleasure, namely by washing the paper, in the manner described, with galls of nitrate of silver, or with any other chemical liquids which act upon those parts of the paper only, which have been previously acted upon by light. Fourthly, The using hot or boiling substances of the hyposulphites in order to give increased whiteness to Talbotype photographic pictures, and at the same time make them exceedingly permanent. Fifthly, The waxing Talbotype negative pictures, in order to make them transparent and thus to facilitate the obtaining positive copies therefrom, the said pictures having been previously whitened by immersion in the hot solution of hyposulphite, as last mentioned."

---

36. For an *Improvement in the Steam Pile Driver;* James Nasmyth, Patricroft, Lancaster county, England, June 26, (in England, September 17, 1846.)

The patentee says,—"The principal feature in this my invention consists in the first place, in the employment of the pile which is about

to be driven, for the support of the pile-driving part of my apparatus which being of considerable weight, consisting as it does of the cylinder, constructed like that of a common single acting steam cylinder, a hammer block or monkey, which is a heavy weight attached to the piston rod of the steam cylinder and a cylindrical or other formed case, which is attached to the lower end of this cylinder, and acts as a guide to the monkey and encloses the head of the pile on which it rests; these together weigh about three tons (more or less) and very importantly aid the driving of the piles by predisposing it to penetrate into the ground.

"The second feature of novelty consists in the application of the direct acting steam hammer to the driving of piles.

"A third feature of my invention consists in the manner in which I cause the pile, while it is being driven, to become as it were part and parcel of the machine. A fourth feature of novelty in this my invention, consists in the peculiar manner in which, by means of a jointed steam pipe, I am enabled to convey the steam from the boiler to the cylinder, at whatever position the cylinder may be with respect to the boiler."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, firstly, the employment of the pile to be driven as the foundation or base on which to rest my pile-driving apparatus. Secondly, the manner in which I secure and guide the pile in its descent by its temporary attachment to, or connexion with, the driving apparatus and upright frame work of the machine. And thirdly, I claim the combination of the movable engine with the boiler, by means of jointed steam pipes, capable of accomodating themselves to the varying position of the machine during the descent of the pile, substantially as herein described."

---

37. For an *Improvement in Cutting Round Tenons on the Ends of Spokes;* John McCune, Senecaville, Guernsey county, Ohio, June 26.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the before-described mode of cutting round tenons on the ends of the spokes of carriage wheels by means of an apparatus constructed as described, suspended to the end of each spoke, during the operation of cutting the round tenon thereon."

---

38 For an *Improvement in Harvesting Machines;* John Dunlap, Geneva, Walworth county, Wisconsin, June 26.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the swinging brush, swinging on the shaft of the reels in the inside of the reels, as described, and in combination with the stationary brush for the purpose, as herein set forth and described."

---

39. For an *Improvement in Railroad Coal Cars;* Ross Winans, Baltimore, Maryland, June 26.

The patentee says,—"The principle of my invention by which I

am enabled to attain these important ends consists in making the body, or a portion thereof, conical, by which the area of the bottom is reduced, and the load exerts an equal strain on all parts, and which does not tend to change the form, but to exert an equal strain in the direction of the circle. At the same time this form presents the important advantage, by the reduced size of the lower part thereof, to extend down within the truck and between the axles, thereby lowering the centre of gravity of the load."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is making the body of a car for the transportation of coal, &c., in the form of a frustrum of a cone, substantially as described, whereby the force exerted by the weight of the load, presses equally in all directions, and does not tend to change the form thereof, so that every part resists its equal proportion; and by which also the lower part is so reduced as to pass down within the truck frame and between the axles, to lower the centre of gravity of the load, without diminishing the capacity of the car as described."

---

40. For an *Improvement in Trusses;* Albert G. Bartlett, Oxford, Butler county, Ohio, June 26.

The patentee says,—"My said invention consists of a steel main spring, which surrounds the body, to which is attached an abdominal corset, and two small springs, one of which supports the perineum by means of an oval pad to which it is attached; the other creates a pressure, by means of a wooden block applied to the abdominal rings, inguinal canal, or other parts that may be lacerated in cases of hernia."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the peculiar form of the main spring, as a whole, and, in combination with this form of spring, I claim the form of the inguinal block, and the hernial spring, as above described, and also in combination with this form of spring, I claim the corset substantially as described.

"I also claim the mode of attaching the perineal pad with its spring, so as to allow of the longitudinal motion of the spring, while the pad retains its position, so as to create a constant pressure upon the perineum, during the different motions of the body."

---

41. For an *Improvement in Stuffing Horse Collars;* Wade Haworth, City of New York, June 26.

The patentee says,—"The nature of my improvement consists in an apparatus by which the collar can be stuffed, crooked around the block or former on which it is shaped."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the block and stuffing apparatus, consisting of the stuffing board, rods, and clamps, or other analogous device, by which the collar can be stuffed and formed into shape around the block at the same time, substantially in the manner and for the

purpose set forth; the whole operation of stuffing and forming being completed in one machine as herein described."

---

42. For an *Improvement in Rotary Steam Engines;* Mahlon Gregg, Philadelphia, Pennsylvania, June 26.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the manner in which I have arranged and combined the apparatus for governing the steam valves, and reversing the motion of the steam engine; said apparatus consisting of the cam wheel, the valve slide, the two valves, and the two shifting inclined planes, these parts being combined with the engine, and operating substantially in the manner and for the purpose made known. I do not claim the general manner in which I construct my engine, the steam chamber, and the pistons, being similar in their operation to those used in other rotary engines; but I limit my claim to the particular arrangement and combination of the parts above designated, by which I obtain the ends of governing the admission of steam, and of reversing the motion of the engine, in a manner which I believe to be new, and which is convenient, simple, and efficient."

---

43. For an *Improvement in Elevating Water;* Daniel Winder, Hagerstown, Washington county, Maryland, June 26.

The patentee says,—"The object of my invention is to raise water by atmospheric pressure, above the height due to the pressure of one atmosphere, and the nature of my invention consists in connecting the lower part of an air tight receiver, placed in the lower part of a well, with a pump placed more than thirty-two feet above the back of the water in the well, by means of a pipe provided with a two-way cock, that the pump may communicate with the receiver, or with the atmosphere, which pump communicates with another air tight receiver, above it, the top of the said upper receiver being connected with the top of the receiver in the well, by means of a pipe, and the lower part thereof, by means of another pipe, with the tank or tanks above it, into which the water is to be raised. The tube which connects the pump and lower receiver is exhausted, that the water from the lower receiver may be forced up by atmospheric pressure, to the height due to the pressure of one atmosphere; the two-way cock is then turned, to close this communication, and open the pipe to the atmosphere, for the purpose of drawing in air, and compressing it in the upper receiver, which being in connexion with the top of the lower receiver, the elastic force of the air acts on the surface of the water in the lower receiver, to force it up to the height of the pump; so that, re-turning the two-way cock, to re-establish the communication between the pump and lower receiver, the water will be forced up into the pump, and thence transferred to the upper receiver, from which it will be forced up the delivery pipe, by the elastic force of the compressed air."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the lower receiver placed in a well or other reservoir of

water, in combination with the pump placed more than thirty-two feet above the level of the water in the well or reservoir, and with the upper receiver; the pump and lower receiver being connected by means of a pipe, provided with a four-way cock, or other valve, so that the pump may connect with the receiver or the atmosphere, and the two receivers being connected by means of an air pump, that the air forced into the upper one by the pump, may act on the surface of the water in the lower receiver, and force the water up to the pump, to a height greater than is due to the pressure of one atmosphere, as herein described."

List of American Patents which issued in the month of September, 1842, with Exemplifications, by CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

1. For an *Improvement in Moulding Brick;* Alfred Hall, Cleveland, Ohio, September 3.

The patentee says,—"The nature of my invention consists in constructing a moulding machine, to be attached to a common tempering tub, with revolving knives of the usual construction, from which the mortar is conducted directly into the moulds, into which it is forced by the press; to this machine an apparatus is affixed for removing the moulds, and when obstructed by stones, &c., to relieve them therefrom."

Claim.—"What I claim as my invention, and desire to secure by letters patent, are the segment slides, operated on by springs, in combination with the platen and hopper, constructed and arranged as herein set forth.

"I further claim the combination of the carriage, suspended at its rear end with the connecting rods and shaft, for freeing the machine from obstructions, substantially as before specified.

"Lastly, I claim the construction of the carriage, so as to free itself from dirt, that is to say: the pivots and studs for steadying the carriage, the slatted top and railway set off from the carriage, &c., and in combination therewith, the movable carriage, constructed and operated as herein described."

---

2. For an *Improvement in the Cotton Press;* Robert Harding, South Berwick, York county, Maine, September 3.

Claim.—"I do not claim the application of the right and left hand screw, to operate the two pairs of toggle joints as above described; nor do I claim the manner of operating two pairs of toggle joints by horizontal pitmen, connecting to a central movable piece; but what I do claim, and desire to secure by letters patent, as my invention, is the manner of combining the toggle joints, moved by a right and left handed screw, operating on the movable centre piece, with the toggle joints moved by the horizontal pitmen, constructed and operating as above described."

3. For an *Improvement in Fire Engines;* Joseph Briggs, Jr., St. Louis, Missouri, September 3.

Claim.—"What I claim as my invention, and which I desire to secure by letters patent, is the combination of the partitions with the pipes as described."

---

4. For an *Improvement in Forming and Using Spikes, Brads, &c.;* James Buckelew, Spottswood, Middlesex county, New Jersey, September 3.

The patentee says,—"To the lower or entering ends of my nails or spikes, which I make flat, like a firmer, or chisel, I give a slope or chamfer, resembling that ordinarily given to firmers, leaving them flat, or nearly so, on one side, and giving them a bevel on the other.

"When they are intended to be driven into soft wood, the bevel or bend is to be greater than when they are to be driven into hard wood. In using these spikes or nails, a hole is to be bored into the wood into which they are to be driven, to such a depth as it is desired to drive them without their beginning to clinch; and when driven beyond this point, the chamfer and bend, or the chamfer alone, or the bend alone, which they have previously received, will cause them to curve round, and to clinch themselves in the wood in any desired degree."

Claim.—"What I claim as new, and desire to secure by letters patent, is the manner of using the spikes, nails, or brads, which I denominate self-clinching, and to which I give a determined amount of chamfer, or of bend, or of both combined, so that they shall begin to clinch when driven into wood, either with or across the grain, the wood being bored for their first entrance, to the depth to which it is desired they should reach without clinching, and there made to turn by the form given to the spike itself, without its being necessary to aid it by the insertion of a plate of iron, or any other analogous device."

---

5. For an *Improvement in Railways;* William Emmons, City of New York, September 3.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application and use of metallic plates or wedges, for the purpose of causing the spikes, used for securing the iron rails or chairs, or other parts of railroads, to be clinched in manner above described, and for other purposes."

---

6. For an *Improvement in Locomotive Engines;* Robert L. Stevens, City of New York, September 3.

Claim.—"What I claim as my invention is not the general application to the purposes of machinery, of the principle of connecting wheels by adhesion, as above described, but the manner of adapting it to a locomotive engine, by means of a spring, and by which the advantages above named may be secured."

7. For an *Improvement in Saw Mills;* D. V. Thomas, Richfield, Otsego county, New York, September 17.

The patentee says,—"The nature of my invention consists in an apparatus for setting and gauging the log by a slide, which is moved by running back the carriage in a manner hereafter described."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the lever, in combination with the graduating lever, hand and ratchet wheel, for the purpose and in the manner herein set forth."

---

8. For an *Improvement in Portable Baths;* Lucien E. Hicks and Thomas Minor, Middletown, Connecticut, September 17.

The patentees say,—"The nature of our invention consists in constructing a portable bath, for the purpose of creating and applying to any part of, or to the whole surface of, the body, the vapor made from the articles, and in the manner hereafter mentioned."

Claim.—"What we claim as our invention, and desire to secure by letters patent, is the covered chair, constructed with a circular iron hoop, having attached to it joints for adjusting the curtain, and with iron rods enclosing the sides of the chair, there being a door on one side, opening to the heating apparatus. Also, a perforated metallic plate, beneath the seat, thereto attached, for the purpose of admitting, and for reflecting the product of the heating apparatus, and likewise a conductor to the feet, in combination with the metallic fountain and tubes, for distributing the fluids, with the heating and evaporating apparatus, constructed with a reservoir for cold water, and a cover containing two divisions, one for burning alcohol, and the other containing materials to be volatilized, or sublimed, with an evaporating pan above these; the whole being constructed and operating as above described."

---

9. For an *Improvement in Hinges and Fastenings for Window Blinds;* William Baker, Utica, Oneida county, New York, September 17.

The patentee says,—"The nature of my invention consists in connecting the window blind fastening with the lower blind hinge, by adding to the hinge a latch, or hook, by which the blind is fastened and held, without any fastening on the back side of the blind, or on the wall of the house, and in adding certain other improvements, by which the hinge is strengthened and improved."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the connecting the window blind fastening with the hinge, either by the use of the latch, made as a double fastening, that is, to fasten the blind, both when closed and when open, or when made to fasten the blind when open only; or by the use of the hook on the back of the hinge, for fastening the blind open as described."

10. For an *Improvement in Bee Hives;* Jesse W. Davidson, Rome, Richland county, Ohio, September 17.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the upper or swarming box, and its small honey boxes, with the collateral hive boxes below, constructed and arranged substantially as described."

---

11. For an *Improvement in Stoves;* George Nelson, Boston, Massachusetts, September 17.

Claim.—"Having explained my invention, I shall claim forming the upper part of the fire chamber, converging as set forth, in combination with the vertical partitions, connecting the fire chamber (so constructed) with the external casing, by which arrangement of the above parts, air, to be heated, is brought into contact with a greater extent and degree of warming surface, than would be obtained were the fire chamber continued vertically to the top plate of the apparatus as heretofore described."

---

12. For an *Improvement in Pumps;* Henry Rodgers, Moravia, Cayuga county, New York, September 17.

The patentee says,—"The object of my improvement is to cause one pump to serve for the raising of two kinds of liquid from a cellar or other apartment, containing barrels or other reservoirs, having in them the kinds of liquid which are to be raised and delivered in a store, or bar room, or other place where they may be wanted, through tubes, without the liquid passing through, or into the body or main cylinder of the pump.

"The body of my pump consists of a metallic cylinder, of such capacity as may be required, and this is furnished with a piston, the rod of which extends downwards through the lower end of the cylinder, and is worked by a lever under the counter, or in any other convenient situation.

"From the head or cap of the upper end of the main cylinder, ascends a tube, which enters the side of a metallic faucet, through an aperture therein, and which said faucet is open at the top, and from two sides of which last mentioned cylinder descend two tubes, which pass through the caps of the first mentioned cylinder, and thence one to pass through the floor, and are to be connected respectively with the barrels or other vessels, cisterns, or wells, from which the liquors or other liquids are to be raised. In the upper end of the faucet there is inserted a spigot, or key, which is to be turned like that of a common cock, and which, by the position it is made to occupy, will determine the kind of liquor or other liquid to be drawn, and direct its discharge into the vessel which is to receive it. To the lower end of the said fount, which is also open, is firmly attached a tubular glass, also open at both ends, below which is a detached movable tubular glass or other vessel, closed at the lower end, and placed upon a movable stool, with a spiral wire spring bottom, by which the upper end of this tube, which is open, is

or may be pressed up against the lower end of the tube above, so as to make the joint air-tight, and into which last mentioned tubular glass or other vessel, the liquor, water, or other liquid, raised by the pump, is to be discharged, which may be moved when filled, or when it has received as much of the liquid as is desired."

Claim.—"Having thus fully described the nature of my invention, what I claim as new, and desire to secure by letters patent, is the manner in which I raise the liquor, water, or other liquid, through the tubes, without its passing through or into the cylinder, in which the piston is worked, by means of exhausting the air contained in the other vessels in close coaptation with the lower edge of the tubular glass, and thereby causing the liquor, water, or other liquid, to rise up the said tubes, and discharge itself into such tumbler, or other vessel, enabling the piston to be worked in oil, and thereby saving it and the inside of the said cylinder from corrosion, and the liquor, water, or other liquid, raised, from the impurities necessarily engendered or secreted in all other pumps. The whole apparatus being constructed and operating substantially as herein described."

---

13. For an *Improvement in Bridles for Horses;* John C. Smith, Brookhaven, Suffolk county, New York, September 17.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the manner of constructing and arranging the blinders, in combination with the curved braces attached to the top of the head stall, and the use of the curved braces as applied to the other description of blinds.

"I likewise claim the apparatus for sustaining the ears of the horse at any required angle, whether constructed as described, or in any other mode substantially the same, in combination with the head stall and curved braces, attached to the blinders as described.

"I also claim the manner of adjusting the ends of the reins, to correspond with the carriage of the horse, by means of strap and buckle, as described."

---

14. For an *Improvement in Making Wigs, Frizettes, &c.;* F. Deville, Baltimore, Maryland, September 17.

The patentee says,—"In my improved wigs, I dispense entirely with the ordinary spring frame, and substitute therefor steel springs, which I make out of wire, of about the size of that used for common sized pins. These wires are each about six inches long, and they are to be flattened by hammering, and to be bent into a form resembling that of the letter U, and brought to a good spring temper. Four springs of this size and kind, I find sufficient to cause a wig to fit closely to the head. In forming the wig, the springs are to be so arranged as to cause them to act upon the outer edge of the foundation or tissue, which constitutes its lining, so as to draw it closely all around its edge, without the exertion of any direct pressure by the springs upon the head itself, their action being entirely lateral."

Claim.—"What I claim as new, and desire to secure by letters pat-

ent, is the employment of four or any preferred number of springs, formed and operating substantially in the manner herein set forth, and applied to the foundation or lining of a wig, so as to cause the same to bind around the head, and effectually to retain it in place, and by which I dispense entirely with the metallic spring frame, which has heretofore been generally employed; the arrangement of such springs being substantially the same with that herein set forth and represented."

---

15. For an *Improvement in Shingle Machines;* Alex. H. Hart, Chagrin Falls, Cuyahoga county, Ohio, September 17.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the lever, stirrup, and foot, tooth wheel, metallic levers, and upper and lower carriages, for the purpose of feeding the machine in the manner described. The construction of these parts, or the combination of the screw wheels and racks, the tooth wheel, and foot, or of any other parts separately, is not claimed."

---

16. For an *Improvement in Washing Ores;* Dexter L. Dauvergne, Clarkesville, Habbersham county, Georgia, September 17.

Claim.—"I am aware that machines for various purposes have been made with a vertical shaft, having arms or agitators projecting from it, and revolving within a casing, and therefore I do not claim this as my invention; but what I do claim, and desire to secure by letters patent, is the combination of the conical shaft, with agitators or arms projecting from it, in combination with the outer conical case, provided with holes, and plugs or pins, to let out the water as the washing progresses, and these, thus combined. I further claim, in combination, the cup at the bottom of the conical case, which receives the mercury for forming the amalgam; the whole being constructed and arranged substantially as herein described."

---

17. For an *Improvement in Ploughs;* Hiram L. Norton, Granville, Washington county, New York, September 23.

Claim.—"What I claim as my invention, and which I desire to secure by letters patent, is the arrangement of the two rollers on the mould board, in the manner, and for the purpose set forth, or in any other mode substantially the same."

---

18. For an *Improvement in Pumps;* William L. Jacobs, Lancaster, Pennsylvania, September 23.

The patentee says,—"The main improvement I have made, and for which I solicit letters patent, is enclosing the vibrating beam and axle, and the upper ends of the connecting rods of the valve boxes, in a tight water box in which they work, and into which the water is raised, secure to the upper ends of the cylinders, having an air vessel

and pipe, of the usual form and construction, attached to said water box. Grooves are formed on the under side of the water box, corresponding, in size and shape, with the upper ends of the cylinders inserted therein. Similar grooves are formed on the upper side of the box, into which the lower ends of the cylinders are inserted. Suitable packing is inserted into these grooves, to render the joints tight. The cylinders are held firmly between the boxes, and in the aforesaid grooves, by a screw bolt, or bolts, which has a head on the upper end, and a nut on the lower end."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is constructing the pump with the axle and vibrating beam, to which the pistons are attached, arranged inside the water box, and working therein as described, in the manner and for the purpose herein set forth."

---

19. For an *Improvement in the Hydrostatic Pump;* Robert G. Eunson, City of New York, September 23.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the above mode of pumping the water and air from the condensers of steam engines, viz: By using the pressure of steam in place of the piston, in manner described: by a pump consisting of two barrels of unequal height, the water in the lower being pressed upon by the steam, either by the exhaust from the cylinder, or by the steam direct from the boiler, in combination with the float, chains, shafts, counterpoises, valves, &c., in manner described, or in any other substantially the same, and also the cut off, viz: opening and shutting the throttle valve so as to prevent jarring, by means of the curved lever being acted upon by a lever and slide, and this lever acted upon by the rod, spring, catches, and slide, in manner described, or in any other substantially the same, either as applied to my pump, or for the common purposes of a cut off."

---

20. For an *Improvement in Tailor's Shears;* Thos. J. Sloan, City of New York, September 23.

The patentee says—"The nature of my invention consists in adapting the upper bow to the thumb, so that it shall have a more equal bearing than shears now in use, and in constructing the lower bow so as to swivel as the fingers open and shut, the joint being so formed as prevent the edges of the shears from shaving each other."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the so forming the upper bow, and crooking the shank of the shears, that the thumb can have a bearing its whole length upon the lower section, parallel to the blades, in the manner herein described.

"I also claim the construction of the lower bow, so as to swivel in the shank, having a rest under it, in the manner, and for the purpose above set forth. I further claim the forming a steady fulcrum for the blades of the shears, by means of a socket joint, bearing upon the two rings, constructed and arranged as specified."

21. For an *Improvement in Composition, for rendering Wood, &c. impermeable to Water and Dampness;* Charles Lyon, City of New York, September 23.

The patentee says,—"The nature of it consists in applying to a box, prepared for the purpose, a composition that will not only coat the surface, but also saturate the substance of the wood, and thus prevent the passage of water.

"Take six pounds of coal tar, half pound of gum shellac, and one pound of rosin, melt them together, and apply the composition to the surface of the wood or other material, to be rendered impermeable to water. To impregnate the wood with it, I generally apply a hot iron, not so hot as to burn it, and rub it in; by this means the composition penetrates entirely through an inch board."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the composition above described, (or any other substantially the same) with the dry plaster, to render a box, chest, or any other thing, impervious to air, water, and dampness; the said composition being applied to any or all sides of a double or triple box, and the dry plaster packed between, as described."

---

22. For an *Improvement in Spark Arresters;* Samuel G. Brown, Henrietta, Monroe county, New York, September 30.

Claim.—"I do not claim merely the peculiar arrangement as represented, but I claim the principle and parts illustrated in the following words, to wit:—I claim as my invention, and desire to secure by letters patent, the method of extinguishing sparks by means of cylindrical or circular screens, fixed and made to revolve in smoke flues, so constructed as to contain, each, a portion of water, or carbonic acid gas, into which a part of the screen is immersed, as above described; also the method of producing or increasing the draught in *furnaces, flues, and stacks,* by exhausting them of heated *air, smoke, &c.*, by means of pumps, as herein described; also the making of apertures in the lower, or bottom part, or parts, of the cylinders of said exhausting pumps, which apertures lead into boxes or chambers, attached to their cylinders, into which the ashes, &c. that settle in said cylinders, will, by the action of their pistons, be caused to pass as described."

---

23. For an *Improvement in the mode of cutting, &c. the Sails of Vessels from rolls of canvass;* John Dominis, a citizen of the United States, now residing in the Sandwich Islands, in the Pacific Ocean, September 30.

The patentee says,—"As sails of different kinds and for different vessels are formed of strips of cloth or canvass sewed together, after they are cut to proper shapes and lengths, and as it is customary to cut said strips from what is usually termed a roll or bolt of canvass, it becomes desirable to accomplish the same, with as little waste of

material as possible, or in other words, so to measure the lengths and gore of each strip, that when the whole are sewed together, the sail thus formed shall possess the desired shape, and in nautical language, set well when adjusted and exposed to the action of the wind.

"In order that the use and adaptation of my improvements may be more particularly understood, I shall proceed to state the mode usually practised of cutting the cloths of a sail from a long or extended piece of canvass.

"We will suppose, for the purpose of explanation, that we wish to cut up a roll of canvass for the purpose of converting the same into a sail usually termed a jib. To cut the first cloth, presuming the canvass is square on the end, it is necessary to set up from the end a certain determined distance (called the gore on the foot—and which we will suppose six and one half inches,) on either selvage of the canvass, and there make a suitable mark. Then cut from the said mark diagonally across the canvass to the extreme point of the opposite selvage, and thus we shall have formed the foot gore for the first cloth.

"Next measure up on the selvage from the foot or mark above mentioned, the length of the after leech, (which suppose forty-two feet,) then from the extremity of the distance so measured, set downwards another certain determined distance called the gore on the stay, and which we will suppose to equal four feet and four inches. Next following the filling thread, so marked across the strip of canvass, to the opposite selvage, and make a suitable mark thereon, which mark will be in a line perpendicular to the selvage. Next cut the cloth from the last mentioned mark diagonally to the mark denoting the length of the first cloth, and thus we form the stay gore for the first and second cloths. Turn the canvass so as to bring the longer selvage even in a line with the shorter selvage of the first cloth. Measure down by this cloth for the length of the second cloth, and mark it; thence take a thread as before to the opposite selvage; thence set off six and one half inches (the foot gores) downwards; mark it and cut diagonally as before to the mark denoting the length of the second cloth on the opposite selvage, and thus we obtain the foot gore or slope of the second and third cloths. Turn the canvass on the foot, as before, on the head, and continue measuring, turning, and cutting until all the cloths are so prepared."

Claim—"I claim the scales in combination with the other scales, ruler, and circle, the whole constructed, arranged, graduated, and operating together substantially in the manner above mentioned and described, and for the purpose of determining the angle of the gores on the head, foot, and leeches of different sails, as herein above explained.

"I also claim the combination with the above specified parts of the ruled table or card, constructed and arranged substantially as above described, for the purpose of determining the number of breadths or cloths of canvass in a sail, in the manner hereinbefore explained.

"Furthermore, I claim the curved ruler, constructed and arranged

substantially as described, in combination with the rules, table or card, and the scales for the purpose of determining the angles of the gores of the roach or sweep of the foot of a sail, in the manner herein before explained."

---

24. For an *Improvement in Saw Mills;* Chas. D. Wright, Colchester, New London county, Connecticut, September 30.

Claim.—"What I claim as new, and desire to secure by letters patent, is the manner in which I have formed, combined, and arranged the arm, the kneed lever, the rack and the regulating bolt, and their appendages, so that by the action of the inclined plane on the said arm, the respective parts shall co-operate in setting the log; the whole being constructed and actuated in the manner, or substantially in the manner herein set forth."

---

25. For an *Improvement in the Cultivator;* Marshall J. Hunt, Cincinnati, Hamilton county, Ohio, September 30.

The patentee says,—"In my corn and cotton plough and cultivator, I use three cultivator teeth, which are affixed permanently to the frame by wedges, or screw nuts, and two teeth, or mould boards, which are attached to two sliding bars passing through a mortise at the rear end of the frame; which bars are retained in place by wedges, or otherwise, so as to admit of the placing of the teeth, or of the mould boards, which are attached to them, at such a distance apart, as shall adapt them to the rows of cotton, corn, or other articles under cultivation; and which admits, also, of the shifting of the mould board so as to turn the earth outwards or inwards, against the plant. I also make the drawing bar, or tongue, to which the horse is attached, to rise or fall in such manner as to determine the depth to which the cultivator teeth shall enter the ground."

Claim.—"Having thus fully described the nature of my improvements in the corn and cotton plough and cultivator, and shown the manner in which the same operates, what I claim as new and desire to secure by letters patent, is the employment of two sliding bars, carrying two cultivator teeth, or two mould boards, which may be shifted and set, in the manner and for the purpose set forth."

---

26. For an *Improvement in Printing Presses*; Joel G. Northup, Cortlandtville, Cortlandt county, New York, September 30.

The patentee says,—"The principal improvement in my Press, consists in the manner in which I bring two or more forms of type, alternately under the platen, or under the cylinder of a printing press, and also under the inking apparatus, for the purpose of inking the forms. The apparatus by which I effect this, may be applied either to a cylinder or to a platen press."

Claim.—"What I claim as new and desire to secure by letters pat-

ent, is first, the combining with a printing press, two or more forms of type, placed on suitable beds; and the carrying them around so as to bring them alternately under the platen of a platen press, or under the cylinder of a cylinder press; the requisite motion being given to them substantially as set forth, and under such modifications as will be rendered necessary by the kind of press to which the improvement is applied. Secondly, I claim in the platen press, the manner in which I have combined and arranged the system of levers, the tympan frame, and tympan, the bed and the stud for moving, reversing, and sliding off the tympan; the respective parts being arranged and operating substantially as made known."

---

27. For an *Improvement in Boring, Tapping, and Reaming Water, or other pipes, under Hydrostatic Pressure;* H. A. Norris, City of New York, September 30.

Claim.—"I claim as my invention, and desire to secure by letters patent, the connexion of the ferulet and drill shaft with each other by means of a sliding or swinging frame, upon which both of them work, according to the principles herein set forth, and by which, either is removed, and the other instantly brought into its place, thus avoiding the necessity of a valve to prevent the flow of water in the interim. I also claim the ferulet shaft, (or any analogous device substantially as herein described for holding the ferulet for insertion,) working in a sliding or swinging frame as herein described, in combination with the drill, whether working in the same frame or not. And I further claim the drill working in a sliding or swinging frame as herein described, in combination with the ferulet shaft, whether working in the same frame or not."

---

28. For an *Improvement in Regulating the Height of Water in Steam Boilers;* Cadwallader Evans, Pittsburg, Allegheny county, Pennsylvania, September 30.

Claim.—"What I claim as new, and desire to secure by letters patent, is the application of a float within a separate cylinder or vessel connected above and below the water line of a steam boiler. The advantage of this arrangement is that there will be no ebullition or foaming in the separate vessel as to agitate the float."

---

29. For an *Improvement in Hemp and Flax Machines;* William McMillen, Ripley, Brown county, Ohio, September 30.

The patentee says,—"The nature of my invention consists in breaking and cleaning hemp in one machine, without handling it, after it enters the machine till it is cleaned, the hemp entering a hopper on the top, and passing down through brakes placed underneath, and after being cleaned, coming out at the bottom ready for market."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is constructing the machine with two breaks and two

pairs of feed rollers, so that the hemp passing down vertically shall be fed from one brake to the other without handling, and in combination therewith the "scutcher," combined and arranged as above described.

"I also claim the spring bars in combination with the stationary swords in the manner and for the purpose herein set forth.

"I also claim the rods, attached to the stationary swords for preventing the hemp from following the movable blades, constructed and combined for the purpose above specified."

---

30. For an *Improvement in Steering Vessels;* George W. and Ezra B. Robinson, Boston, Massachusetts, September 30.

The patentees say,—"The design and purpose of our said invention is to turn the rudders of vessels by a new and more advantageous application of mechanical powers, and without the use of a tiller or tiller ropes.

"For the purpose of using our said invention, the rudder head should rise above the deck, nearly as high as the axis of a vertical steering wheel of a convenient diameter and position, which will probably be from twelve to fifteen inches higher than the rudder head is usually made. On the top of this rudder head, which may be made polygonal for the purpose, is fixed a strong metallic horizontal cog wheel of about twenty inches in diameter; playing into the teeth of this wheel, on each side of it, is a horizontal metal rack, moving fore and aft in parallel guides; these racks are to be of such a length and with such a number of teeth as to turn the cog wheel as far each way as the rudder ever needs to turn. This will require the whole length of the racks to be about two feet seven inches, and the teethed part eighteen inches. The guides are in the sides of an oblong frame, long enough to permit the play of the racks and a little higher than the top of the rudder head. The forward end of one of the racks, and the after end of the other, is prolonged solid and without teeth, and bent upwards and turned inwards to the middle of the frame, so as to rise so far above the line of the top of the rudder head, that the bottom of the shaft hereafter described shall be two inches above the rudder head so as to allow the rudder the necessary play up and down. These prolongations of the racks end in hollow nuts above five inches long, with spiral threads cut in contrary directions, that is, with right hand threads in one nut, and left hand threads in the other. These two nuts are in a line with each other, which line passes over the centre of the rudder head, and having bearings on the two ends of the frame, is a horizontal iron shaft about six feet long and two and three quarter inches in diameter; the forward end of which is fixed to the centre of the steering wheel as its axis. Where this shaft passes through the nuts it is formed into two spiral screws, each about twenty inches long, having two or three threads of such obliquity as to give about two-and-a-half inches at each turn of the wheel, to enable the rudder to give sufficiently to the force of the seas. One of the screws is a right hand screw, and the other a left hand screw corresponding to the nuts above described. On the after end of the shaft, and out-

side of the frame, is placed a vertical steering wheel of the usual size and form. As the steering wheel is turned, the spiral screws on the shaft move one rack forward and the other back, turning the cog wheel and the rudder to the right or left as required. Instead of having the frame supported at the after end, it may be bolted into the stern frame of the vessel, and properly braced, by which it may be made to occupy less room on the deck."

Claim.—"What we claim, and desire to secure by letters patent, is the machine or combination, consisting of the cog wheel on the rudder head, the sliding racks, with the hollow nuts and screws, the shaft, with the right and left hand screws, and the steering wheel; the whole combined as before described, and for the purpose aforesaid."

MECHANICS, PHYSICS, AND CHEMISTRY.

Translated for the Journal of the Franklin Institute.

Account of the Experiments to determine the Principal Laws and Numerical Data, which enter into the Calculation of Steam Engines. By M. V. REGNAULT.

(Continued from page 55.)

FIFTH MEMOIR.

On the Absolute Dilatation of Mercury.

As the dilatation of mercury is one of the most important data in Physical experiments, it has been, as might be expected, determined by a great number of experimenters. As, however, they have had in view for the most part, only the correction of the height of the barometrical column due to changes of temperature, their experiments have but seldom been carried much above atmospheric temperatures, and the value of this important quantity accepted by philosophers is that determined by Dulong and Petit, for temperatures from 0° to 300°. (32° to 572° Fahr.) *(Annales de Chimie et de Physique, tome VII, p.* 124.*)*

It is to be regreted that these skilful experimenters did not publish their actual results, but only a few means, which, even supposing them perfectly exact, are insufficient for the wants of science, as they do not permit us to trace the curve of the dilatations which it is necessary for us to know with great precision.

But these numbers are necessarily inexact, since they were calculated with a coefficient for the dilatation of air, much too great; for this error, however, the proper allowance may now be made, and M.

Regnault gives a corrected table of their results which is as follows:

Temperature by air thermometer.		Mean absolute dilatations of mercury.	
Fahr.	Cent.		
32°	0°		
212°	100°	$\frac{1}{5677}$	0·00017615
392°	200°	$\frac{1}{5550}$	0·00018018
572°	300°	$\frac{1}{5433}$	0·00018440

The method used by Dulong and Petit for their experiments consisted in placing the mercury in two tubes 0·55 metre in height, connected below by a tube of very small diameter; one of the vertical tubes was surrounded by ice, and the other immersed in a boiler filled with oil, which could be heated to the desired temperature. The advantage of this method is that it is totally independent of any hypothesis, and of any correction for the dilatation of the tubes, reposing simply upon the hydrostatic law, that if two columns of liquids of different densities communicate with each other at their base, their heights above the plane of contact are inversely as their densities. The simple observation of the difference in the height of the columns, therefore, gives the means of determining the change of density in the heated column, and since the densities are inversely as the bulks, this will give the increment of bulk: that is, the dilatation, for the known temperature.

M. Regnault, however, makes the following practical objections to these experiments:—

1st. As it was necessary to observe directly the tops of the mercurial columns, that in the heated oil was required to rise a short distance above the surface of the bath, and the temperature of this part of the column was uncertain.

2nd. The oil bath could not be stirred up during the experiment; the temperature of the oil therefore differed at different heights above the furnace.

3rd. The capillary action in the two tubes was not the same, because the temperatures of the columns were very different.

4th. The difference of the heights of the two columns was very small, and required to be measured with extreme nicety; and he shows, from their own record of the maximum and minimum values of these differences, that their instruments were not sufficiently delicate to give the precision which the experiments, from their close accordance with each other, appear to have.

Lavoisier and Laplace, in their determination of the dilatation of mercury, used another method. They observed the apparent dilatation of mercury enclosed in a glass reservoir, and determined the

linear dilatation of the reservoir by observation of a rod of the same kind of glass.

By a proper modification of this method it would be possible to determine directly,—1st, the temperatures, deduced from the dilatation of the air;—2nd, the linear dilatation of the glass tube;—3rd, the apparent dilatation of mercury in the same tube. To calculate from this the absolute dilatation of mercury it must be assumed:

1st. That the cubic dilatation (δ) and the linear (λ) are connected by the formula $\delta = 3\lambda + 3\lambda + \lambda^3$,
which will be true only when the material dilates equally in all directions, which depends upon its molecular condition.

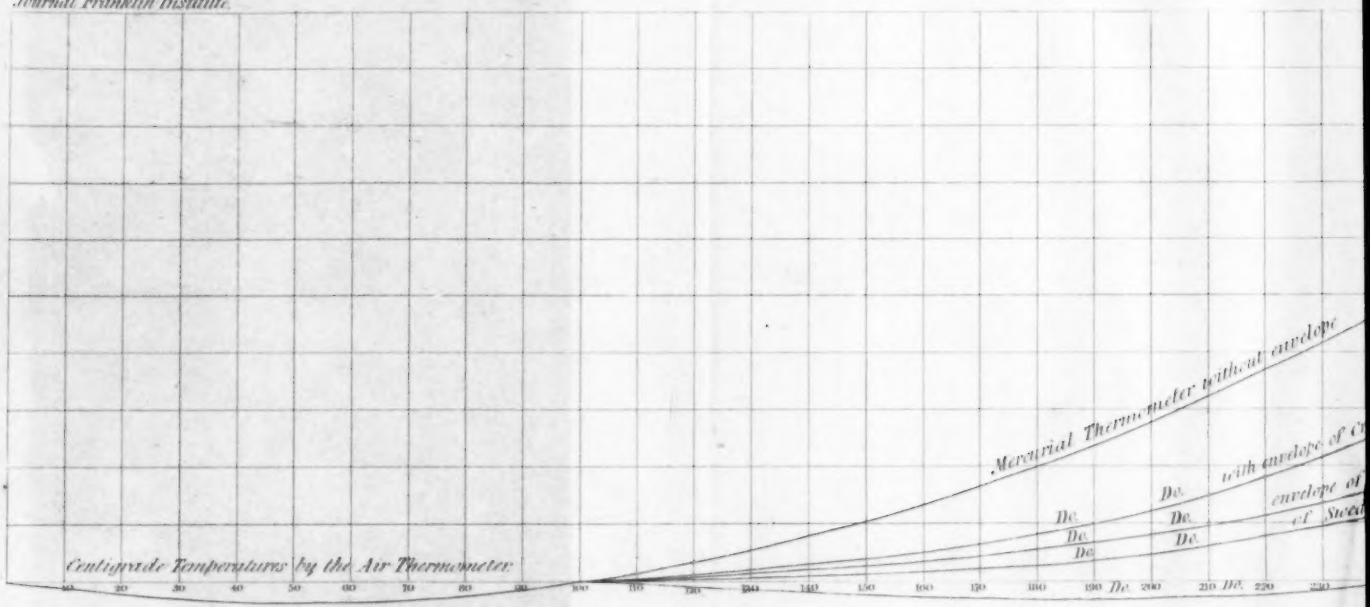
2nd. That the dilatation of the envelope is exactly that which it would be, if it made part of a solid and continuous body of the same substance; a hypothesis again based upon mathematical considerations, but never yet subjected to the test of experiment.

By their mode, Lavoisier and Laplace determined the dilatation of mercury between 0° and 100° to be 0·01811.

The apparatus used by M. Regnault is founded upon the first method, that of observing the difference of heights of two communicating columns, but is so arranged as to avoid the practical objections which he has pointed out in the apparatus of Dulong and Petit.

The description of the apparatus and the method of experimenting, however, would occupy so much space that we omit them with the simple remark, that no pains seem to have been spared to insure minute accuracy.

The following table includes the values calculated from his experiments by means of graphic projection, and a parabolic formula of interpolation:—



Differences between the Temperatures shewn by Mercurial Thermometers, and those given by an Air Thermomet

linear dilatation of the reservoir by observation of a rod of the same kind of glass.

By a proper modification of this method it would be possible to determine directly,—1st, the temperatures, deduced from the dilatation of the air;—2nd, the linear dilatation of the glass tube;—3rd, the apparent dilatation of mercury in the same tube. To calculate from this the absolute dilatation of mercury it must be assumed:

1st. That the cubic dilatation (δ) and the linear (λ) are connected by the formula $\delta = 3\lambda + 3\lambda + \lambda^3$,
which will be true only when the material dilates equally in all directions, which depends upon its molecular condition.

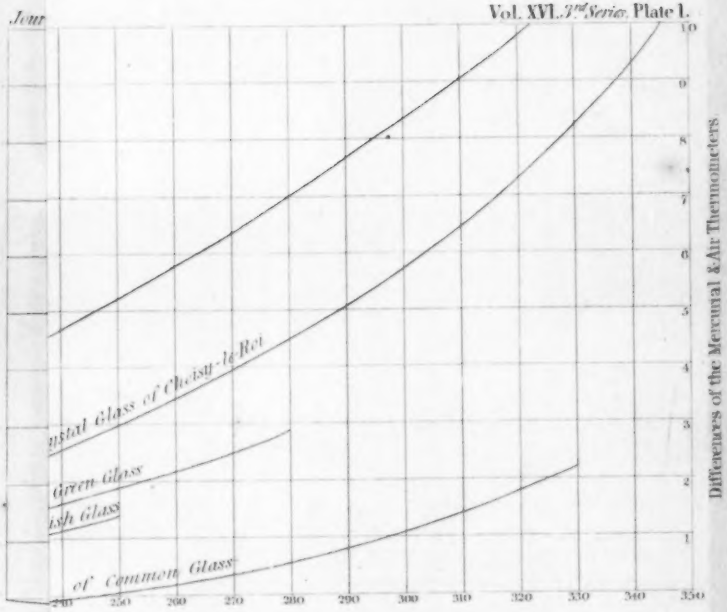
2nd. That the dilatation of the envelope is exactly that which it would be, if it made part of a solid and continuous body of the same substance; a hypothesis again based upon mathematical considerations, but never yet subjected to the test of experiment.

By their mode, Lavoisier and Laplace determined the dilatation of mercury between 0° and 100° to be 0·01811.

The apparatus used by M. Regnault is founded upon the first method, that of observing the difference of heights of two communicating columns, but is so arranged as to avoid the practical objections which he has pointed out in the apparatus of Dulong and Petit.

The description of the apparatus and the method of experimenting, however, would occupy so much space that we omit them with the simple remark, that no pains seem to have been spared to insure minute accuracy.

The following table includes the values calculated from his experiments by means of graphic projection, and a parabolic formula of interpolation:—



r corrected for the Dilatation of its Envelope.

Table of the True Dilatations of Mercury.

Temperature by air thermom'r		Dilatation of mercury from 0° to T.°	Mean coefficient of dilatation from 0° to T.°	Real coefficient of dilatation at T.	Temperature deduced from absolute dilatation of mercury.	Difference betw'n a thermometer founded upon the absolute dilatat'n of mercury, and the air thermometer.
Fah.	Cent. T	δ_T	δ	$\frac{d.\delta_T}{d.T}$	θ	$(\theta - T)$
°	°				°	°
32	0	0·000000	0·00000000	0 00017905	0	0
50	10	0·001792	0·00017925	0·00017950	9·872	— 0·128
68	20	0·003590	0·00017951	0·00018001	19·776	— 0·224
86	30	0 005393	0·00017976	0·00018051	29·709	— 0·291
104	40	0·007201	0·00018002	0·00018102	39·668	— 0·332
122	50	0·009013	0·00018027	0·00018152	49·650	— 0·350
140	60	0·010831	0·00018052	0·00018203	59·665	— 0·335
158	70	0·012655	0·00018078	0·00018253	69·713	— 0·287
176	80	0·014482	0·00018102	0·00018304	79·777	— 0·223
194	90	0·016315	0·00018128	0·00018354	89·875	— 0·125
212	100	0·018153	0·00018153	0·00018305	100 "	0·000
230	110	0·019996	0·00018178	0·00018455	110·153	+ 0·153
248	120	0·021844	0·00018203	0·00018505	120·333	+ 0·333
266	130	0·023697	0 00018228	0·00018556	130·540	+ 0·540
284	140	0·025555	0·00018254	0·00018606	140·776	+ 0·776
302	150	0·027419	0·00018279	0 00018657	151·044	+ 1·044
320	160	0·029287	0·00018304	0·00018707	161·334	+ 1·334
338	170	0·031160	0·00018329	0·00018758	171·652	+ 1·652
356	180	0·033039	0·00018355	0·00018808	182·003	+ 2 003
374	190	0·034922	0·00018380	0 00018859	192·376	+ 2·376
392	200	0·036811	0 00018405	0 00018909	202·782	+ 2·782
410	210	0·038704	0·00018430	0·00018959	213·210	+ 3·210
428	220	0·040603	0·00018456	0·00019010	223·671	+ 3·671
446	230	0·042506	0·00018481	0·00019061	234·154	+ 4·154
464	240	0·044415	0·00018506	0·00019111	244·670	+ 4·670
482	250	0·046329	0·00018531	0·00019161	255·214	+ 5·214
500	260	0·048247	0·00018557	0 00019212	265·780	+ 5·780
518	270	0·050171	0·00018582	0·00019262	276·379	+ 6·379
536	280	0·052100	0·00018607	0·00019313	287·005	+ 7·005
554	290	0·054034	0·00018632	0·00019363	297·659	+ 7·659
572	300	0 055973	0·00018658	0·00019413	308·340	+ 8·340
590	310	0·057917	0·00018683	0·00019464	319·048	+ 9·048
608	320	0 059866	0·00018708	0·00019515	329·786	+ 9·786
626	330	0·061820	0·00018733	0·00019565	340·550	+ 10·550
644	340	0·063778	0·00018758	0·00019616	351·336	+ 11·336
662	350	0·065743	0·00018784	0·00019666	362·160	+ 12·160

SIXTH MEMOIR.

On the Law of the Compressibility of Elastic Fluids.

When a gas enclosed within a space with movable walls, is exposed to a constantly increasing pressure, it is reduced to a smaller and smaller bulk. Boyle *(Defensio contra Linum)* and Mariotte *(Œuvres de Mariotte, La Haye,* 1740; *tome* I. *De la Nature de l'air, page* 152*)* were the first philosophers who endeavored to determine the law of this contraction.

The experiments made upon atmospheric air led them to establish a very simple law, known frequently as the *law of Boyle*, but more generally as the *law of Mariotte. The volumes which the same mass of air occupies at a constant temperature, are inversely proportional to the pressures which the gas sustains. Or in other words: The densities of air at the same temperatures, are proportional to the pressures.* Since their time, a great number of philosophers have sought to satisfy themselves by experiment whether this law ought to be admitted rigorously for atmospheric air under the heaviest pressures, and whether it was applicable to other elastic fluids.

Boyle had already thought that he had remarked that for pressures above four atmospheres the air was less compressed than it ought to be according to this law. Muschenbrock *(Cours de Physique, Paris,* 1759, *tome* III, *p.* 142,*)* came to a similar conclusion.

Sulzer, *(Memoires de Berlin, Année* 1753, *p.* 116,*)* in experiments carried up to eight atmospheres, found, contrary to the conclusions of Boyle and Muschenbrock, that starting even from a single atmosphere, the air was compressed much more than the law of Mariotte indicated.

Robinson, *(System of Mechanical Philosophy, Vol.* III, *p.* 637,*)* thinking that the differences observed by Sulzer arose from the fact of the air not having been completely dried, made new experiments upon air dried by quick lime, moist air, and air charged with the vapor of camphor, but he found the differences greater than those which presented themselves in the experiments of Sulzer.

MM. Œrstedt and Swendsen *(Edinburgh Journal of Science, Vol.* IV, *p.* 224*)* published in 1826 a series of experiments performed with a more perfect apparatus than that of their predecessors, and they concluded that, up to eight atmospheres, the air followed almost exactly the law of Mariotte. It is to be remarked that all the differences between their experimental results and those of the theory are positive, which would go to prove that the air is really compressed a little more than it ought to be according to the law; but as the differences do not increase regularly with the pressures, they are rather to be attributed to errors of observation.

In the foregoing experiments the elastic force of the gas was measured by the weight of the column of mercury which equilibriated it, but they could not be carried beyond eight atmospheres. MM. Œrstedt and Swendsen sought by another method to verify the law of Mariotte under heavier pressures. For this purpose they compressed the air in the reservoir of an air-gun. They determined the weight

of air introduced, and consequently its density, by means of a balance. The elastic force of the gas was measured by the pressure exerted upon a steel valve fitted upon the reservoir, and kept closed by means of a movable weight sliding upon a counter-balanced lever. The weight was gradually slid along the lever until the elastic force of the air raised the valve. This method employed to determine the pressures, cannot give precise measures, and the results can only be considered as approximations. Nevertheless we may conclude from these experiments, that, up to a pressure of sixty-eight atmospheres, the atmospheric air does not depart considerably from the law of Mariotte.

The same experimenters examined whether the law of Mariotte applied to other gases. For this purpose they compared, under similar circumstances, the compressibility of a gas easily liquefied, such as sulphurous acid, with the atmospheric air. They found that up to two or three atmospheres the two gases followed sensibly the same law, but that from that point upwards the compressibility of the sulphurous acid became greater, and increased with the pressure; so that when the condensation of the atmospheric air was 3·189, that of the acid was 3·319. The liquefaction of the sulphurous acid took place at a pressure a little above this, at the temperature at which they operated.

M. Despretz confirmed this latter result by new experiments, and found by a similar process that the gases sulphurous and hydrosulphuric acids, cyanogen and ammonia, compared with atmospheric air, departed from the law of Mariotte and presented compressibilities increasing with the pressures, even from two atmospheres; that hydrogen and atmospheric air moved sensibly together up to 15 atmospheres, but he adds that, at the pressure of 20 atmospheres, the air leads notably.

Finally, the last uncertainties existing as to the law of Mariotte, applied to atmospheric air, seemed to disappear after the beautiful experiments which MM. Arago and Dulong *(Memoires de l'Academie des Sciences, tome* x. *Annales de Chimie et de Physique, tome* XLIII, *2de Serie, p.* 74*)* undertook at the request of the Academy, the object of which was to determine the relation existing between the elastic forces and temperatures of saturated steam.

These illustrious philosophers determined the law of contraction of the atmospheric air up to 27 atmospheres; the volumes of the gas were measured in a tube graduated into equal capacities, and 1·7 metre in length, and the elastic forces were measured by the heights of the columns of mercury which counterbalanced them.

In 39 determinations which they made upon the same mass of air submitted to pressures varying from 1 to 27 atmospheres, the differences between calculation and observation never amounted to $\frac{1}{100}$, and these differences did not increase with the pressure, as they should have done if they were owing to a real deviation from the law of Mariotte.

The principal object of MM. Dulong and Arago in these experiments was not, however, to verify the law of Mariotte, but to construct

a compressed air manometer *(pressure-gauge)* graduated directly by means of the column of mercury, which might serve to measure the tensions of steam at high temperatures. On this account, their apparatus was not arranged in the most favorable way to determine slight divergences which might occur from the law of Mariotte. With this apparatus, as with all others which have been heretofore employed for the same purpose, the principal difficulty consists in the precise measurement of the volume of the air.

Lately, M. Pouillet has undertaken the determination of the law of condensation of some other elastic fluids. All that is known of his labors is by an extract which he has published in the fourth edition of his *Elements de Physique, tome* 1, *p.* 327. His method of experimenting was similar to that followed by MM. Œrstedt and Despretz, the tubes in which the gases under comparison were enclosed were two metres long.

M. Pouillet deduced from his researches the following conclusions:

1st. Up to 100 atmospheres, oxygen, nitrogen, hydrogen, nitric oxide, and carbonic oxide, follow the same law of compression as the atmospheric air.

2d. The gases sulphurous acid, ammonia, carbonic acid, and nitrous oxide, begin to be notably more compressible than the atmospheric air, as soon as their volume is reduced to ½ or ¼.

3d. Hydrogen, the protocarburet and bicarburet of hydrogen, (olefiant and light carburetted hydrogen gases,) although not liquefied at a temperature of 8° or 10°, under a pressure of 100 atmospheres, have nevertheless a compressibility sensibly greater than that of the air.

Yet, notwithstanding that the most accurate experiments heretofore made seemed to establish incontestably the fact, that up to a pressure of 30 atmospheres the atmospheric air followed rigorously the law of Mariotte, this conclusion seemed to M. Regnault difficult to reconcile with the very notable variations which he had detected in the coefficient of dilatation of atmospheric air, according as it was submitted to greater or less pressures. (See the First Memoir: on the Dilatation of Gases, Journ. Frank. Inst., Vol. xv., p. 282.) The determinations which he had made of the densities of air under pressures less than one atmosphere, (Second Memoir: on the Density of Gases, Vol. xv., p. 361,) augmented his uncertainty upon this point.

The law of the contraction of gases under different pressures, and at a constant temperature, is a fundamental law of physics; it enters into all the determinations which are made with gases, and consequently influences almost all the phenomena of heat; it is therefore of the greatest importance that no uncertainty should remain as to this law. M. Regnault did not therefore hesitate to undertake a new examination of this subject, notwithstanding the imposing authority of the philosophers who had already given their attention to it.

In all the methods which had hitherto been used for the purpose of investigating this law, the principal difficulty consisted in the precise measurement of the volume of the air. The primitive volume of the air being one under the initial pressure of one atmosphere, is but ½,

under a pressure of 5 atmospheres, $\frac{1}{10}$ under a pressure of 10, and $\frac{1}{20}$ under a pressure of 20 atmospheres.

Thus, under heavy pressures the volume is very small, and it becomes impossible to measure it with great exactness, especially if we pay attention to the extreme difficulty which is met with in the exact determination of the diameter of a glass tube, and the uncertainties which result from the variations in form of the meniscus of mercury in various tubes.

But it is easy to avoid all these difficulties, and consequently to obtain great exactness by arranging the experiments according to the following principle.

A glass tube of an interior diameter of from 8 to 10 millimetres, (0·3 or 0·4 inches,) and of 3 metres (9·846 feet) in length, is placed in a vertical position. This tube, closed at its upper extremity by a stop-cock, communicates below with a second very long vertical tube, intended to contain the column of mercury which is to press upon the air inclosed in the first tube. Upon this first tube two marks are placed: one near its lower end corresponds to one volume, the second corresponds exactly to half the capacity of the tube, from its upper end to the first mark, and consequently indicates a half volume.

The tube is filled to the first mark with dry air under a pressure of one atmosphere; this air is then compressed by increasing the height of the column of mercury so as to confine it in the part of the tube above the second mark, its volume is then one-half. If the law of Mariotte is rigorously exact, the elastic force of the gas should then be equal to two atmospheres.

The tube is then filled as before with dry air under a pressure of two atmospheres, and this is, by increasing the column of mercury, compressed into half its bulk; the pressure should then be four atmospheres. The tube is then filled with air under a pressure of four atmospheres, and when compressed into half its bulk, the pressure should be eight atmospheres, and so on.

By this mode of operating, the volume of gas is always large and consequently susceptible of accurate measurement, and as the meniscus is always brought to the same mark, all uncertainty of graduation is avoided.

By placing a third mark, corresponding to one-quarter the volume, it can be determined whether a gas acquires four times the elastic force when compressed into one-fourth its bulk.

In the apparatus of M. Regnault, the long tube for the measurement of the pressures was 24 metres (78·77 feet) long, made of tubes of flint glass, each 3 metres (9·846 feet) long, and connected together by iron tubulures, which by an ingenious clasp could be rendered perfectly tight, yet had no tendency when tightened to twist the tubes, and could be easily and rapidly undone. The tubes were carefully adjusted in the vertical by a plumb line, and it was found that they were quite strong enough to bear the enormous column of mercury, which sometimes filled them. These tubes were made expressly for this purpose at the manufactory of Choisy-le-Roi, and were each three metres in

length, ten millimetres (0·394 in.) in interior diameter, and five millimetres (0·197 in.) thick. M. Regnault determined by careful observations upon marks placed on the tubes, that the enormous pressure brought upon them did not sensibly alter their form or capacity. Marks were placed near the top of each tube, and the distances between these, as well as the distance after connexion between the top mark of one tube and the bottom one of the one immediately above it, were carefully measured. Movable platforms, which permitted the observer to elevate or lower himself at pleasure, allowed the distance of the top of the mercurial column from the nearest mark on the tube to be measured at all times with great accuracy. Four of these tubes, or about 12 metres, were within the tower in which the apparatus was established, the remaining 12 metres of tube were supported upon an elevated and properly braced frame work. Thermometers placed along side of the tube, every 1½ metre (5 feet) gave the actual temperatures, the mean of which was taken as the temperature of the column.

The following corrections were calculated and applied to the immediate data of observation:—

1st. On account of the differences of the atmospheric pressure upon the summit of the manometric column, and upon the cistern of the barometer which was below. The correction for this, for a difference of 25 metres, was 2·375 mm.

2d. On account of the compressibility of the mercury, the correction for 25 metres was 1·356 mm.

3d. For the augmentation of internal capacity of the tube which contained the air, under the heavy pressures. This, it was shown, might be altogether neglected, as it did not amount to $\frac{1}{15,000}$ under a pressure of 25 atmospheres.

4th. For the changes of temperature of the air while under measurement. This never amounted to more than a few hundredths of a degree, (the tube was kept cool by a constant stream of water,) and this change was indicated by a very sensitive thermometer, and reduced to invariability by calculation.

The deductions which M. Regnault draws from his experiments (the tabulated results of which will be found at the end of this abstract) are as follows:—

1st. The atmospheric air does not rigorously follow the law of Mariotte, but is in reality compressed a little more than it ought to be according to that law, and these differences increase regularly with the pressures.

2d. Nitrogen gas presents the same anomaly as the atmospheric air.

3d. In the case of carbonic acid, the differences are so considerable, that under heavy pressures the law of Mariotte cannot even be considered as approximately true.

4th. Hydrogen gas does not follow the law of Mariotte better than the air; but what is remarkable, departs from it in the opposite direction. Whilst the air and the other gases hitherto studied are compress-

ed more than they ought to be according to the law of Mariotte, hydrogen gas shows a *less* compressibility than the law gives, and this compressibility diminishes as the pressure increases. The elastic force of hydrogen is therefore similar to that of a metallic spring, which offers a greater resistance to compression, in proportion as the pressure to which it is already subjected is greater.

This last result appears to be of very great importance for the mechanical theory of gases. We are accustomed to look upon the law of Mariotte as the mechanical expression for a *perfect gas.* When a gas does not follow this law rigorously, and its compressibility is greater than it ought to be, we consider the gas as *imperfectly elastic*; a condition which has already been recognized for a great number of gases. These experiments show that it is true even for atmospheric air and nitrogen. For all these gases the law of Mariotte may be considered as a *limiting law*, which is not rigorously observed except when the gases are infinitely dilated, and from which they depart more and more, in proportion as they are in a more condensed state.

These considerations are greatly modified by the experiments on hydrogen gas. If the law of Mariotte were the mathematical expression of a perfectly gaseous state, hydrogen would be a *more than perfect elastic fluid*, following the law of Mariotte *at the limit*, that is, when it is extremely dilated, but opposing an elastic resistance which becomes greater with its state of condensation. It is nevertheless probable that this elastic resistance does not augment indefinitely with the condensation; in other words, it is probable that the ratio (obtained by dividing the ratio of the volumes by the inverse ratio of the pressures) $\frac{\left(\frac{V_0}{V_1}\right)}{\left(\frac{P_1}{P_0}\right)}$ (which we shall hereafter for simplicity write ρ) attains a certain minimum which is perhaps placed far beyond the limits of our experiments, that it afterwards increases and approaches unity, which it attains at a certain state of condensation, in the vicinity of which it follows the law of Mariotte strictly. The condensation augmenting, hydrogen departs again from the law of Mariotte, in the opposite direction; the ratio ρ becomes greater than unity, and goes on increasing until the gas is liquefied.

The temperature certainly exercises a great influence upon this phenomenon. It has been shown (in the memoir upon the density of gases, Vol. XV, p. 361) that carbonic acid gas departs notably from the law of Mariotte under pressures less than one atmosphere, when it is kept at a temperature 0°, but that it no longer departs from it to a sensible degree for very light pressures, when kept at a temperature of 100°.

In studying the compressibility of atmospheric air at high temperatures, it will be found that it departs much less from the law than it does at ordinary temperatures within the same limits of density; and it is likely that a temperature might be obtained at which the divergencies would not be observable. It is even very probable that

at a still higher temperature, the atmospheric air would depart again from Mariotte's law, but in the opposite direction: that is, in the direction in which hydrogen departs at ordinary temperatures.

Similar circumstances, but in an inverse order, will present themselves for hydrogen, when submitted to temperatures lower and lower.

M. Regnault thinks that there exists for every gas, taken at a certain state of condensation, a temperature at which it follows sensibly the law of Mariotte for limited variations of pressure; that is at which $\rho - 1 = 0$. (It will be remembered that we write ρ for $\frac{\left(\frac{V_0}{V_1}\right)}{\left(\frac{P_1}{P_0}\right)}$.)

Below this temperature the gas, in the same state of condensation will present a greater compressibility than that belonging to the law; that is, we shall have $\rho - 1 > 0$; this is the condition in which we find the air, nitrogen, carbonic acid, &c., at ordinary temperatures.

On the contrary, above this temperature, the gas in the same state of condensation will present a less compressibility than that deduced from the law; that is, $\rho - 1 < 0$, and the gas will be found in the condition seen in the case of hydrogen gas at ordinary temperatures.

The temperature at which the function $\rho - 1$ changes its sign, varies necessarily for every gas, with its density; it is higher as the density is greater.

It will be seen, from what has been said, that it would be of the greatest importance to study the compressibility of the gases at high temperatures; unfortunately this study presents almost insurmountable difficulties from the impossibility of obtaining stationary high temperatures.

M. Regnault then proceeds to give a sketch of two methods for such determinations, which as they have not been applied in practice, we omit.

(To be Continued.)

On the Construction and Power of a new form of Galvanic Battery. By the Rev. NICHOLAS CALLAN, *D. D., Professor of Natural Philosophy in Maynooth College.*

In a paper published in the August number of the London Philosophical Magazine, I described several experiments, which clearly prove that, as a negative element of the nitric acid battery, lead coated with chloride of gold or platina, or with borax dissolved in dilute acid, is superior to platina, and that cast iron is fully as powerful as platina. I have since compared, in various ways, the power of a cast iron battery with that of a Grove's of equal size. The cast iron was excited by a mixture consisting of about four parts of sulphuric acid, two of nitric acid, and two of nitre dissolved in water. The platina was excited by equal parts of concentrated nitric and sulphuric acid. The

zinc plates of both batteries were excited by dilute sulphuric acid of the same strength. The cast iron battery was considerably superior to Grove's, in its magnetic power, in its heating power, and in its power of producing decomposition. The magnetic effects of the two batteries were compared by means of a galvanometer and of a small magnetic machine. Grove's produced a deflection of 82°; the cast iron caused a deflection of 85°. When the voltaic currents of the two batteries were sent simultaneously, in opposite directions, through the helix of the galvanometer, the current from the cast iron battery destroyed the deflection caused by Grove's, and produced an opposite deflection of 60°. In the magnetic machine, the cast iron battery produced fifty revolutions in a minute; Grove's produced only thirty-five in the same time.

The superiority of the heating power of the cast iron battery was shown by its fusing a steel wire, which Grove's only raised to a dull red heat. I have been told by persons who tried the two batteries, that they found the heating power of the cast iron battery to be twice as great as that of Grove's.

The decomposing powers of the two batteries were compared by the quantities of the mixed gases which they produced during the space of three minutes. The result clearly established the superiority of the cast iron battery.

I have tried various kinds of cast iron, and have found them all to possess nearly equal power. I have got cast iron plates containing oxide of chromium: they did not appear to have any advantage over common cast iron. Perhaps, by mixing with cast iron some of the more negative elements, an increase of power may be obtained.

Soon after I had discovered the great electromotive power of platinized lead and cast iron, when excited by nitric or nitro-sulphuric acid, I proposed to the trustees of the College to change our Wollaston batteries into a platinized lead or cast iron one. They readily authorized me to expend the sum required for the change. After weighing well the relative advantages of platinized lead and cast iron, I resolved on the latter, principally because I found that it did not require to be platinized.

In this battery, which was exhibited in the College on the 7th of the last month, there were 300 cast iron water-tight cells, each containing a porous cell and zinc plate 4 inches square; 110 cast iron cells, each holding a porous cell and zinc plate 6 inches by 4; and 177 cast iron cells, each containing a porous cell and a zinc plate 6 inches square. The zinc plate of each circle was placed in a porous cell, and the latter in a cast iron cell. The inside of each cast iron cell was about a quarter of an inch wider than the exterior of its porous cell. Slips of sheet copper, about an inch broad, and 2½ inches long, were soldered to each cast iron cell, and to each of the 320 six-inch zinc plates. The 4-inch plates were already furnished with screws and nuts. Each iron cell was connected by a binding-screw with the next zinc plate. The iron cells were kept in an upright position in nine wooden frames, which were placed on wooden supports nearly three feet high. The battery was charged by pouring into each cast iron cell a mixture containing

about twelve parts, by measure, of concentrated nitric acid, and eleven and a half parts of double rectified sulphuric acid; and, by filling to the proper height, each porous cell with dilute nitro-sulphuric acid, consisting of about five parts of sulphuric acid, two of nitric, and forty-five of water. In charging the entire battery, we used about fourteen gallons of nitric, and sixteen of sulphuric acid. I abstained from using the solution of nitre, through an apprehension that it would cause the exciting mixture in the cast iron cells to boil over. I know not whether this apprehension is well founded; but I know that when ten or more cells are employed, the exciting fluid in the cast iron cells will soon boil over, and produce nitrous fumes, if it does not contain one-quarter of its bulk of nitric acid.

I have found by experiment, that a cast iron battery is about fifteen times as powerful as a Wollaston battery of the same size, and nearly as powerful and a half as Grove's. Hence our new cast iron battery, in which there are 96 square feet of zinc, is equal in power to a Wollaston battery containing more than 1400 square feet of zinc, or more than 18,000 four-inch plates, and to a Grove's containing 140 square feet of platina. Now the battery made by order of Napoleon, for the Polytechnic School, which was the largest zinc and copper battery ever constructed, contained only about 600 square feet of zinc; and the most powerful Grove's of which I have seen an account, did not contain 20 square feet of platina. Hence the cast iron battery belonging to the College, is more than twice as powerful as the largest Wollaston, and seven times as powerful as the largest Grove's ever constructed.

I shall now describe a few of the experiments which were made with our large cast iron battery on the 7th of the last month. The first experiment consisted in passing the voltaic current through a very large turkey, which was instantly killed by the shock. The craw of the turkey was burst, and the hay and oats contained within it fell to the ground. In order to give the shock, a piece of tin-foil, about four inches square, was placed under each wing along the sides of the turkey, which were previously stripped of their feathers, and moistened with dilute acid. The tin-foil was kept in close contact with the skin, by pressing the wings against the sides. The person who held the turkey had a very thick cloth between each hand and the wing, in order to save him from the shock. As soon as the wire from the zinc end of the battery was put in contact with the tin-foil under one wing, sparks were given by the tin-foil, and shocks received by the turkey, before the connexion was made between the negative end of the battery and the tin-foil under the other wing, although the negative and positive ends of the battery were on tables nearly 3 feet high and 3 feet asunder.

When a copper wire, in connexion with the negative end, was put in contact with a brass ring connected with the zinc end of the battery, a brilliant light was instantly produced. The copper wire was gradually separated from the brass ring until the arc of light was broken. The greatest length of the arc was about 5 inches. As soon as the connexion was made between the opposite ends of the battery, by the

copper wire, which was ¼ of an inch thick, about 5 feet long, a loud noise was produced, by the combustion of the solder which fastened some of the copper slips to the zinc plates. I immediately went to the part of the battery from which the noise proceeded, in order to try whether the connexion between the cast iron cells and zinc plates was broken; I found one slip of copper detached from the zinc plate to which it had been soldered. There were probably others disconnected with their zinc plates, but I did not find them. The result of this experiment showed that the turkey conducted only a part of the current circulated by the battery, for the current which killed the turkey, produced no combustion of the solder by which the copper slips were attached to the zinc plates.

We next tried the ignition of charcoal points. We were not able to determine the length of the arc of light between them; for before Sir Robert Kane had time to separate them, they were burned away. The light was, of course, most brilliant; the charcoal scintillated like steel or iron. I never before observed these scintillations in the combustion of charcoal. Coke points were also ignited, and a most intense light produced; but during the experiments with the coke points, the circuit was interrupted, in consequence of the fracture of one of the porous cells, which caused the dilute and concentrated acids to mingle together, and, consequently, to boil over, until the porous and cast iron cells were nearly emptied. Notwithstanding this interruption of the circuit, the arc of light between the coke points was about an inch long, and the heat of the flame deflagrated a file.

I had arrangements made for a long series of experiments on the decomposing power of the voltaic current, and of voltaic heat, and on the illuminating power of the various kinds of voltaic light; but these experiments I was obliged to omit, through fatigue, exhaustion, and bad health. I have since tried the illuminating power of the light produced by the ignition of coke points; and, for the gas microscope and polariscope, have found it far superior to the oxyhydrogen lime light. With good coke points, abundant light for the microscope and polariscope may be obtained from a battery containing 25 cast iron cells, and as many zinc plates, each 2 inches by four: if the coke be not very good, 40 plates will be required. When an iron cell, 2½ inches wide, and 4 inches high, is large enough to contain between it and the porous cell, nearly a wine-glassful of the concentrated acids, the battery will work with undiminished power for about three hours, without any additional acid. If the cell containing the zinc plates be small, it will be necessary to pour in a little dilute acid every half hour. I have got the lime light by igniting the mixed gases, as they were produced by the decomposition of water, and throwing the flame on lime.

Maynooth College, April 6, 1848. **Lond. Phil. Mag.**

A New Method of Separating Magnesia from the Alkalies.

Heintz separates the magnesia from solutions containing potash and soda in the following manner:—

The solution containing the three bases is supersaturated with ammonia, and if it contain no chlorides, a few drops of sal ammoniac are added. Should a troubled appearance arise in the liquid, it is treated with sal ammoniac until this vanishes. The magnesia is then precipitated by phosphate of ammonia, the precipitate washed with ammoniacal water, dried, heated to redness, and weighed. The free ammonia in the filtrate having been partly removed by boiling, the phosphoric acid is precipitated at the boiling temperature, by nitrate or acetate of lead. When an excess of the lead salt has been used, a solution of carbonate of ammonia, containing free ammonia, is added to the hot liquid, which is then allowed to stand for some minutes. It is subsequently filtered, and the amount of potash and soda contained in the filtrate is ascertained by the usual methods.—*Pogg. Ann.* LXXIII. p. 119.

Quar. Jour. Lond. Chem. Soc.

On the Preparation of Prussian Blue, generally known as "Turnbull's Blue." By ROBERT WARINGTON, Esq.

In bringing the present notice before the Society, I feel it necessary to apologize for introducing a subject to their attention which has been so ably investigated by many of our most eminent chemists, and the results of whose labors are to be found in the Chemical Manuals of the present day. Yet, when we find substances in commerce, under this title, or under the various magnified appellations of "Egyptian blue," "Cerulean blue," &c., differing exceedingly in character from each other, some of them of great beauty in color, and frequently possessing modified properties; when the difficulty attending the preparation of this blue of a uniform tint, which is a great source of annoyance to many of the makers, is also taken into consideration, I am induced to believe that the results of the investigation may not be deemed uninteresting to the members of this Society, or unimportant to the manufacturing chemist. The greater part of the experiments were made in the year 1834, and many of them have been lately repeated; the investigation has also been extended, for the purpose of confirmation, before being submitted to the Society.

I must premise, that the great object in view in commencing this investigation, was the production of a color analogous to what was then known as "Turnbull's blue," and was, at the period I allude to, made, I believe, only by the firm of Turnbull and Ramsay, of Glasgow; its extreme beauty, and the bright, metallic, coppery lustre exhibited on its surface, will be well known to most of our members. I need hardly say that numerous unsuccessful experiments were made, before anything approaching the desired tint was obtained. Its attempted production from a persalt of iron, by various and modified processes, was unsuccessful in every case; nothing comparable with it in lustre or beauty was obtained. After trying the different persalts of iron, the method of peroxidizing the protosalt was varied, and this was followed by the action of the ferridcyanide of potassium on the protosalt, in place of the ferrocyanide on the persalt, but the result was still not perfectly satisfactory.

In the course of these experiments, however, certain points were noted, which ultimately led the way to the desired result; one of the principal of these, and that which bears most fully on the present subject, was the fact, that the precipitate produced by a solution of the ferrocyanide of potassium, in the solution of a protosalt of iron, has a most powerful affinity for oxygen; every one must be aware of this to a certain extent, inasmuch as the precipitate absorbs oxygen from the air, and becomes deepened in color; but so energetic is this attraction, that many solutions of the salts of metallic oxides are deoxidized rapidly and perfectly, when brought within the sphere of its action; many of the blue salts of copper are rendered colorless, salts of chromic acid are reduced to salts of the green oxide, sufficient acid being present to hold in solution the protoxide of chromium which is produced; salts of peroxide of tin, mercury, and iron, are also rapidly reduced to the state of protosalts.*

The precipitate, in either of these cases, darkens and becomes gradually of a deep blue color, which is more or less intense as the quantity of the metallic salt, or the proportion of oxygen contained in it, varies; the fine, metallic, coppery lustre is at length gradually developed.—As this effect could thus be produced by salts of a metallic oxide, there was no apparent reason why the same result should not be arrived at with solutions of other agents containing oxygen, either in large quantity or feebly combined, as, for instance, in chloric acid and its salts, and in chlorous acid.

Another point was also rendered evident from the above experiments, namely, that it was actually necessary that the precipitate formed in the protosalt of iron by ferrocyanide of potassium, should first be produced, in order to obtain the state of molecular aggregation in the compound, capable of yielding a blue of the fine color and lustre sought, and upon which, as a basis, the effect of oxidizing agents could be fully developed. The composition of this precipitate, or white Prussian blue, has been pretty well ascertained by numerous investigators, and is represented by the formula:

$$2\,(Cy_3\,Fe)+Fe_3+K, \text{ or } Cy_6\,Fe_4+K.$$

It is produced by the action of two equivalents of the ferrocyanide of potassium, upon three equivalents of the protosulphate of iron; thus:

$$3\,(Fe\,O, SO_3)+2\,(Cy_3\,Fe, K_2) \text{ give rise to}$$

$$3\,(KO, SO_3)+2\,(Cy_3\,Fe)+Fe_3+K,$$

or sulphate of potash and the white Prussian blue.

*I may mention here that this re-action with the salts of iron affords an excellent means of securing a solution of this metal, in the state of protoxide, for the purpose of exhibiting its peculiar re-actions in the class room, experiments which are, at times, attended with some little annoyance. For this purpose, a solution of the ordinary proto-sulphate of iron is to be partially precipitated, in a well-corked or stoppered bottle, by a solution of the ferrocyanide of potassium, and the precipitate allowed to subside; it will then be found that this precipitate has reduced the remaining part of the solution to the state of protosulphate most perfectly, and that this is now capable of yielding a pure white precipitate, both with solutions of the carbonated alkalies and with additional solution of the ferrocyanide of potassium. The same effect may be produced by adding a portion of the recently precipitated ferrocyanide of iron to a solution of sulphate of iron.

Now the question arises, as to what chemical action takes place during the darkening in color, or oxidation of this compound, through the medium of oxidizing agents, and I shall presently be able to show, that it is the conversion of the equivalent of potassium, which forms one of its ingredients, into potash, and the removal of the potash at the same time, by the agency of an acid, with which it is able to combine. I have already shewn that there are various agents by which this oxidation may be effected; those which I have found to answer the purpose most efficiently, are: 1st, the bichromate of potash; 2d, the chlorate of potash; 3d, a soluble persalt of iron; 4th, chlorinated soda, or a solution of chloride of lime.

When bichromate of potash is employed, it is necessary to use one-third of an equivalent only, as the salt will afford three equivalents of available oxygen, and to effect our object perfectly, one only is required; thus,

$KO, 2\,Cr\,O_3 + 4\,SO_3$ will yield $(KO, SO_3 + Cr_2\,O_3, 3\,SO_3) + O_3$

or one equivalent of bichromate of potash, treated with four equivs. of sulphuric acid, will give rise to one equiv. of sulphate of chromium and potash, (chrome alum,) and three equivs. of oxygen, and as the single equivalent of potassium we wish to oxidize requires only one equiv. of oxygen, the third part of an equiv. of the bichromate will suffice for our purpose; an additional equivalent of sulphuric acid is, however, indispensable for the purpose of uniting with the potash resulting from this oxidation.

When chlorate of potash is used as the oxidizing agent, about one-fifth of an equivalent is sufficient for the oxidation, the requisite proportion of hydrochloric acid being added to decompose the salt, and set the chloric acid free; as in the former case, care must be taken that an eqivalent of sulphuric acid is present, to combine with the resulting potash. The same remarks will equally apply to the employment of chlorinated soda, or chloride of lime; the latter compound, however, is objectionable, from the sulphate of lime which is necessarily produced when protosulphate of iron or sulphuric acid is made use of in the operation. In the third case, where a persalt of iron is the oxidizing medium, and in these experiments I have always employed the persulphate, the preparation of which will be immediately described, a single equivalent is necessary to yield the one equiv. of oxygen, and sufficient sulphuric acid is contained in this solution to combine with the oxidized potassium, after the iron has been reduced to the state of protoxide, by the action of the white Prussian blue; thus,

$$Fe_2\,O_3, 3\,SO_3 = 2\,(Fe\,O, SO_3) + O + SO_3.$$

That this action is owing to the oxidation and subsequent removal of the equivalent of potassium, will, I think, be evident from the fact, that when the bichromate of potash is employed in the proportion stated, the supernatant liquor has the pinkish-blue color of the double sulphate of chromium and potash; but if more than this be used, a portion of bichromate remains in solution, exhibiting its characteristic orange color. The same remarks apply to the persalt of iron, any excess above the equivalent required, being found in the filtrate or supernatant liquor, when the Prussian blue has subsided.

To prepare the persulphate of iron, I have found that either bichromate of potash, or chlorate of potash, may be employed with much greater advantage than nitric acid; care must be taken that sufficient sulphuric acid is present to hold the peroxide of iron produced in solution; and also, in the first case, to form chrome alum with the deoxidized chromic acid; the decomposition of the chlorate of potash should always be effected by hydrochloric acid. Now as the protosulphate of iron assumes an additional half equivalent of oxygen, to form persulphate, it will be evident that one-sixth of an equivalent of bichromate of potash, or one-tenth of an equivalent of chlorate of potash, with the requisite proportion of acid, will be sufficient for this conversion. When the oxidizing solution is prepared with chlorate of potash, the solution, after the oxidation of the white Prussian blue, may be precipitated by ferrocyanide of potassium for a future operation; if bichromate has been used, the protoxide of chromium will, to a certain extent, be precipitated by the ferrocyanide of potassium, and interfere with the brilliancy of the subsequent color.

The white Prussian blue should be precipitated from dilute solutions, in order to obtain an uniform product in the proper state of aggregation. I find that when the materials are respectively dissolved in about ten times their weight of water, a very good result is obtained.

It is well known that when Turnbull's blue is digested in a solution of the ferrocyanide of potassium, a pale or white Prussian blue and ferridcyanide of potassium result; this is best effected by acting on one equivalent of the former with two of the latter, and the action may be illustrated thus:

$2(Cy_3\,Fe),Fe_3+2\,(Cy_3\,Fe,K_2)=2\,(Cy_3\,Fe),Fe_3,K+C_6\,Fe_2,K_3$.

The result being one equivalent of white Prussian blue, and one equivalent of ferridcyanide of potassium.—*Proc. Lond. Chem. Soc.*

Ibid.

On the Estimation of Magnesia by Phosphate of Soda, and that of Phosphoric Acid by Magnesia.

The ordinary method of estimating the quantity of magnesia in solution, by means of tribasic phosphate of soda, is unobjectionable, when ammoniacal water is employed for washing the precipitate; but Weber has satisfactorily proved in the above Memoir, that phosphoric acid in the bibasic modification cannot be accurately determined by magnesia.

The phosphate of magnesia and ammonia, and the pyrophosphate of magnesia, are not precipitated entirely by ammonia from solution in hydrochloric acid; neither is pyrophosphoric acid completely precipitated by the solution of a magnesian salt, even in the presence of ammonia, or an ammoniacal salt. Only, after standing for several weeks in the presence of ammonia, is the bibasic acid converted into the tribasic modification, and rendered capable of forming an entirely insoluble compound with magnesia.

If, therefore, the phosphoric acid in any substance is to be estimated

by magnesia, it must first be ascertained by means of nitrate of silver, whether the acid exist in it in the tribasic or bibasic modification. If the latter is the case, the substance must be fused with from 4 to 6 parts of a mixture of equivalent quantities of carbonate of soda and potash, or treated for a length of time with concentrated sulphuric acid, by which means the bibasic acid and its compounds are converted into tribasic salts.

The pyrophosphates of lime, and the other alkaline earths, are, however, not entirely converted into tribasic phosphates by fusion with carbonated alkali; but by subsequent treatment with sulphuric acid and alcohol, the whole of the phosphoric acid may be obtained in the alcoholic solution. This must then be saturated with carbonate of soda, evaporated to dryness, and fused, in order to determine with accuracy the amount of phosphoric acid present.—*Pogg. Ann.* LXXIII. p. 137. Ibid.

On Steam Navigation. By M. Le Baron Seguier.

The best mode of propulsion for steam vessels has of late been the subject of much enquiry; and many truths have been elicited by the numerous experiments which have been undertaken. Paddle-wheels, (which were the first propellers adopted,) if their floats cease to propel while in contact with the water, will possess many and great disadvantages. Every time that (from the rolling of the vessel, or the action of the waves) a float, in a horizontal position, strikes the water, it does not act in a manner to propel the vessel forward, but tends to raise it; and the weight of the vessel being more than equal to the power which rotates the wheel, it will either be quite stopped, or its speed much slackened. An enormous amount of power is thus expended in retarding the progress of the vessel, instead of propelling it. Moreover, all the floats being fixed, when one of them, in rising out of the water, only possesses an angular speed, inferior to the momentum acquired by the vessel, the lower floats themselves become an obstacle to its forward progress; as, in that case, they must be added to the section of the vessel as a resisting surface. On suspending the action of the propeller, when it is desired to set the sails, and take advantage of a fair wind, the surface of the lower floats forms a constant resistance, added to that of the midships frame of the vessel. This serious evil can only be avoided, by throwing the wheels out of gear, and allowing them to run loosely; or by the tedious, and sometimes dangerous, operation of dismounting the floats from the lower part of the wheels:—this latter course is preferred.

In order to avoid the evident loss of power, caused by the floats of the wheels not acting uniformly as propellers during the whole time they are in contact with the water, it was proposed to make them movable, whereby they would be protected, whilst still in a horizontal position, from the shock of the waves; and, on leaving the water, they would rise without lifting backwater; but the advantages these mova-

ble paddles presented, were found to be counterbalanced by their comparative want of durability.

Many modifications have also been made in the wheels with fixed paddles; for instance, they have been inclined, and caused to enter the water in an oblique direction to the axis, in order that they may act under the water, according to the principle of White's gearing; they have also been divided in their length and depth, and set in various manners in epicycloïdal curves; wheels have likewise been made with curved floats, in the form of the flukes of an anchor; and floats, pierced with holes, but provided with an extra amount of surface, corresponding to the loss in such perforations, have been tried, to increase their resistance.

The defects of ordinary float-wheels are so manifest, especially at sea, that, ever since the application of steam to marine propelling, a great variety of propellers have been invented for the purpose of superseding their use. Among these are—endless chains furnished with a number of paddles, and running along the sides of the vessel, parallel with the keel; the action of a swan has been imitated, by the alternating motion of jointed rods furnished with blades; the oblique action of the tail of a fish has been imitated, by one or more blades being moved backwards and forwards at the stern; and by screws with one or more threads. This latter contrivance, which was proposed, as an hydraulic mover by Duquet, towards the middle of the last century, and as a propelling apparatus for steam vessels by Dallery, at the beginning of this century, and experimented upon, in all its combinations, by the constructor Sauvage, has not, however, met with approbation. The experiments to which the screw has been subjected, on a large scale, have brought out both its good qualities and defects. The undoubted advantages which it possesses are, simplicity, compactness, and lightness, and its adaptability to the sides or the after part of the vessel. With regard to its defects, they are of two kinds, some relating to its mode of action, and others to its position. The surface of the helix, which will necessarily be of limited dimensions, must, in order to find a sufficient *point d'appui* in the liquid, revolve with considerable speed; the water must, without having time to be displaced, oppose to it the *inertia* of its mass, without which the work will not be effectual. No successful result has been obtained with the helix, until, by means of powerful agents, a rotary motion was communicated to it, sufficiently rapid to cause the water to act as a female screw; the helix then acting as a screw in it, and having its *point d'appui* against the vessel, gave some idea of its power. Resistance being thus obtained in the water, the impulsion is necessarily transmitted to the vessel at a single point, viz: the extremity of the shaft; but here the defects of the helix become apparent; the resistance which the end of the shaft has to overcome, being equal to the power employed to move it, a rapid destruction of the mechanism and loss of power, owing to the friction, are the result. The impossibility, or, at least, the extreme difficulty of getting at the screw and the bearings of its shaft, in a great degree counterbalance the advantages of its submarine position. In consequence of its being placed at the stern of the vessel, a very long shaft is required to com-

municate with the engine, which is situated nearly in the centre; whereby considerable vibration is produced, which cannot be otherwise than prejudicial. When the vessel is sailing, the screw offers a continual obstacle to the progress of the vessel, even if thrown out of gear; but of all its disadvantages, the greatest is the impossibility of repairing this kind of propeller in case it should get out of order at sea.

M. Seguier having observed that steam navigation had not yet arrived at perfection, sought some means of more effectively combining the power of the wind with that of steam. These two modes of propelling may be combined without injury, and will, according to circumstances, produce either the sum of their united forces, or each one, separately, the product of its greatest power.

In order to attain these results, M. le Baron Seguier caused a small experimental vessel to be launched on the Seine, similar in form to the canoes used by Indians, and carrying telescope matting, half wood and half iron, and capable of being set at any required height; its propelling wheels were worked by a steam engine, and furnished with floats turning on pivots.

The idea of these movable floats is not new; in 1819 an iron boat, the "Aaron Manby," constructed in England, proved the disadvantages of a wheel constructed on that principle, when the floats do not work according to the mathematical rules laid down by M. Seguier. Mr. Buchanan, in America, and M. Sciardo, in France, had both the same idea; but they probably did not sufficiently take into consideration the fact, that to ensure the proper action of such propellers, and also their durability, their movements must be so arranged, that the floats shall pivot at their minimum speed, at the beginning and end of every such movement.

The floats on M. Seguier's wheel are independent, and turn on their pivots, which are radial, and work in long bearings of hard metal; the crank with which their axis is furnished, causes them easily to follow a directing curve, which has no other resistance to overcome than the simple friction of the axes or pivots of the float. This curve is adjustable, in order to vary the time of its action on the floats. These floats, being prepared, by a slight deviation of position, for the angular movement which they continually receive from the water upon which they act, give way instead of resisting. All shocks are avoided, by the care which M. Seguier has taken in tracing the directing curve, so as to guide the float, and stop it at its minimum speed. It is this property of the wheel to which M. Seguier attaches the greatest importance, as it is that alone which ensures its durability.

The wheel may be of any size, and several rows of floats, placed in juxta-position, may be guided by one directing curve, so as to move simultaneously; for this purpose it is only necessary to unite all those composing one row by a common rod. By causing the float thus to move in a radial direction, a great advantage is obtained, viz,—that of presenting its edge to the water whenever the movement of the vessel or the water shall be such as to have a tendency to retard the motion of the wheel.

In his directing curve, M. Seguier has substituted for the ordinary

friction of the collar of the eccentric, a rolling friction, by means of friction rollers.

When this wheel is at rest, owing to its floats being able to pivot, the wheel becomes a kind of lee-board, when the directing curve has been so adjusted as to cause the lower floats to assume a position in a line with the keel of the vessel. This much facilitates the progress of the vessel under sail, especially if it is not provided with a high keel, and draws but little water.

M. Seguier's vessel, (the lines of which were laid down by M. de la Morinière, ex-engineer in chief of the Navy,) may be propelled either by the wind and steam combined, or by either separately.—*Bulletin de la Société d'Encouragement.* Lond. Journ. Arts & Sci.

On an Easy Method of Measuring the Distance and Height of an Elevated Point, Accessible or Inaccessible, Fixed or Movable, by Means of a Single Instrument, and by taking the Observation from only one Station. By M. Elie Wartmann, *Professor of Physics in the Academy of Geneva.**

Geodesical and astronomical operations very frequently require the knowledge of the distance of a remote object. If the object be fixed, the ordinary processes of trigonometry readily lead to the desired result. It is only necessary to determine a base, and to measure, from each of its extremities, the angle between the other extremity and the object; we thus obtain the value of two angles and of the adjacent side, from which the triangle is easily resolved.

But for the case in which the distant object is in motion—a case of great importance, and which occurs in several strategical and cosmological problems, the operation is by no means so simple. It would be necessary first to measure a straight line, more or less extended, and to station at its extremities two observers, who at the same instant should direct the telescopes of their theodolites to the same point of the object. When the point is simultaneously visible from the two stations, and the chronometers compared, and when, above all, the object preserves exactly its form, or only changes it imperceptibly, it is conceivable that this method may succeed; and the result will be more exact as the readings are repeated at shorter intervals, in order to lessen the probable errors by means. But when these different circumstances do not exist, when there is only a single observer, or the object varies in appearance, or is not visible at the same time from both extremities of the base, then the execution of the process becomes impossible.

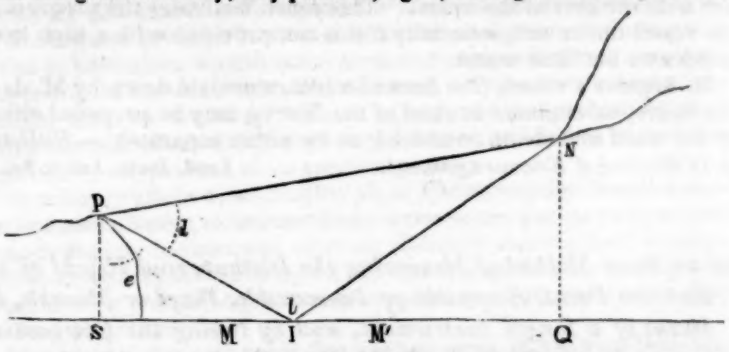
Such are the objections which may be made to the method proposed by M. Pouillet† for estimating the *height of the clouds*, a problem which

* Bulletin of the Sittings of the Vaudois Society of Natural Sciences, tome i. p. 21. (Sitting of February 2, 1842.) See also Pogg. Ann., tome lvi. p. 635; and Gehler's Physikalisches Wörterbuch, tom. xi. p. 700.

† Note on the Height, Velocity, and Direction of the Clouds; Comptes Rendus de l'Academie des Sciences, Paris, tom. xi. p. 717, (Nov. 9, 1840.)

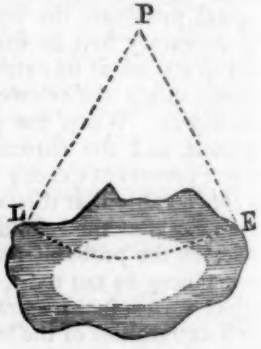
has already attracted the attention of several eminent philosophers, such as James Bernoulli,* Brice,† Lambert,‡ and more recently M. Arago.§ The following is the method which I propose for its solution.

Let us select in a motionless cloud, or in one which does not move with too great velocity, any point N, fig. 1, distinguishable by its color



or peculiar form. Let us place ourselves on an elevated point P, on the summit of a hill or tower, or even at the window of the upper story of a house. Let us have under us a reflecting plane MM', such as a tranquil surface of water or mercury, or a large horizontal glass. The angle of incidence of a luminous ray which strikes a mirror being equal to the angle of reflection, it will suffice to determine the angle d formed by the ray which reaches the eye directly from the point N, with the ray PI which reaches it by reflexion in I, and to estimate the length PI, in order to solve the problem.

In fact, calling e the angle formed by the reflected ray PI with the vertical PS, which passes through the centre of the instrument with which the angle is taken, it is evident that the angle l contained by the incident and reflected rays $=2e$. The two angles d and l being known, it only remains to measure PI. As it might be difficult to determine precisely the point I of the reflecting surface, we may turn the telescope round the vertical, keeping the angle e constant, and seek the length PL or PE of the line joining the point P with the object L or E situated on its margin, (fig. 2.) If the observer is on the top of a vertical wall, or on a tower or house, he will only have to measure its height above the reflecting plane $PS=h$ to deduce



$$PI=\frac{PS}{\cos e}=\frac{h}{\cos e}.$$

* Acta Eruditorum, 1688. † Philosophical Transactions, 1766.

‡ Memoirs of the Academy of Berlin, 1773.

§ Comptes Rendus, tom. xi. p. 323, (August 24, 1840.) Annual of the Bureau on Longitudes, 1840, p. 316.

This value being known, we deduce from it

$$h = \mathrm{PI} \cos e.$$

In like manner since the incident ray

$$\mathrm{IN} = \mathrm{PI} \frac{\sin d}{\sin (d+l)},$$

therefore the vertical height NQ=H of the cloud above the mirror is

$$\mathrm{H} = \mathrm{IN} \cos e = h \frac{\sin d}{\sin (d+l)},$$

and its height $\triangle = \mathrm{H} - h$ above the observer

$$\triangle = h \left\{ \frac{\sin d}{\sin (d+l)} - 1 \right\}.$$

It is sufficient in practice to employ a circle placed vertically and furnished with a tube without lenses. A metallic plate, blackened, and pierced at its centre with a small hole, serves instead of an eye-glass. The tube, the interior of which is likewise black, is furnished with cross wires, and a sufficient length is given it to admit only the useful rays, and not those which are reflected by objects surrounding the point which is observed. The reflecting surface may be a pond, a lake, a large sheet of water, or mercury, &c.

Besides its simplicity, the process which I have described, and which evidently applies in the same cases as the other methods which have been proposed, appears to me to offer some advantages over them.—It is absolutely independent of the presence of the sun above the horizon. The larger the base to be measured PI, the greater will be the approximation. If the point N is only slowly moved, we may employ Borda's method for the repetition of the angles, and thus limit more nearly their exact value: we may, moreover, observe at short intervals of time, and determine the velocity of translation of the object,—a circumstance which it is often useful to ascertain. We remark, lastly, that there is no longer any possibility for a single observer to confound the point of vision with other surrounding points. Now this confusion frequently occurs in the case of a fleeting cloud, and which requires less time to lose its form than is required, in M. Pouillet's method, for two observers to regain their post and observe, after having met to make their arrangements.

If the wind or any other cause prevents the employment of a liquid as the mirror, a very smooth silvered glass might be substituted, of as large dimensions as possible, and be placed horizontally by means of levels or screws, or thin wedges.

Professor Whewell has very recently proposed* to ascertain the height of the clouds, or of a mountain, by means of the formula

$$\mathrm{H} = h \frac{\sin (\alpha+\beta)}{\sin (\alpha-\beta)},$$

in which

H is the height of the cloud above a horizontal mirror,

h the vertical height of the observer above this mirror,

* Reports of the British Association for 1846; Transactions of the Sections, p. 15.

α the angle of depression of the image of any point of the cloud below the horizontal plane passing by the eye of the observer,

β the angle of elevation of the same point above this plane.

It is evident that this formula is identical with that* which I published four years ago, and which has been reproduced in the scientific journals of Germany. The learned Master of Trinity forgot that, at the time when he made his communication to the Section of Physics of the British Association, at Southampton, I informed him that what he proposed as new was already in print.

Lond. Edin. & Dub. Phil. Mag.

Account of the Cost and Durability of Banks's Patent Steel Tyres for Railway Wheels.

Mr. Fothergill read the following paper before the Institution of Mechanical Engineers, Birmingham. The statement of facts relative to Mr. Thomas Banks's patent plan† of steeling the tyres of Railway wheels, is the result of nearly five years' trial, and shows the cost and durability of Staffordshire tyres, steeled on his plan, as compared with Low Moor tyres.

The present cost of Low Moor tyres, for 3-feet wheels, will be—

Four tyres of 3 cwt. each—12 cwt., at 22*s.*	£13 4 0
Putting on the tyres ready for work,	8 0 0
Twice turning up, after wearing hollow,	1 0 0
Total cost,	£22 4 0

Suppose these tyres to run 50,000 miles on an average—that is, 50,000 miles at a cost of £22 4*s.*

The present cost of Staffordshire tyres will be—

Four tyres of 3 cwt. each—12 cwt., at 12*s.*	£7 4 0
Putting on the tyres ready for work,	8 0 0
Steel for steeling one set—1½ cwt., at 42*s.*	3 3 0
Man's wages, for turning grooves in the wheels,	0 10 0
Smith's wages, for inserting the steel,	0 10 0
Man's wages, for turning up after steeling,	0 10 0
Men's wages, for drilling and rivetting,	0 7 6
Total cost,	£20 4 6

These tyres are proved to run, before steeling, 18,000 miles, and after steeling, 100,000 miles—making a total work of 118,000 miles, at a cost of £20 4*s.* 6*d.* Now subtracting 50,000 miles—the work of Low Moor tyres—from 118,000—the work of Staffordshire tyres steeled—we have 68,000 miles, which the latter will run more than the former, and at a cost of 39*s.* 6*d.* per set less. From the above statement, we see the cost of Low Moor tyres per 1000 miles, is 8*s.* 10½*d.*; whilst the cost of Staffordshire tyres, steeled, is only 3*s.* 5¼*d.* per 1000 miles. The truth of this statement is proved by a test of nearly five years' trial, on those lines on which the plan has been most used. We are

* Reports of the British Association for 1846; Transactions of the Sections, p. 15.

† For the specification, See Journ. Frank. Inst., 3rd Series, Vol. vi, p. 212.

aware that railways do not all wear out the tyres alike; but on those lines where the iron tyres will run more than stated above, the steeled tyres will run more in proportion, and the plan is attended with no danger whatever.

Note.—The above statement shows only the advantage of steeling the tyres once, but we have steeled many a second time, after they have run the above distance. The same tyres may be steeled a second time at a cost of £5 per set, when they will run 100,000 miles more—making a total of 218,000, at a cost of £25 4*s.* 6*d.*, or 2*s.* 4*d.* per 1000 miles. The advantage of steeling a second time is secured by taking the tyres in time, while they have the requisite strength for steeling the first time. The general objection against the plan is, that there will be a deal of trouble to carry it out; but this objection, if properly examined, will be found to be without foundation. When the wheels want turning up, they must be taken from under the carriage, or wagon; and, when taken from under, the cutting of the grooves in the tyres, for the steel, will not cost more than 5*s.* per pair in men's wages; and, when the grooves are turned, one smith and three strikers will insert steel segments with 10 pairs of 3-feet wheels in one day of 10 hours; after which, turning up the steeled wheels will take very little more time than turning up without steeling, which proves that the trouble will not be so great as some people imagine, and nothing, when the durability and saving which is effected is considered, by the tyres being steeled on this plan.

The paper was accompanied by a letter from Mr. Jenkins of the Manchester and Leeds Railway, highly commendatory of the steel tyres.

Mr. Peacock remarked, that he had tried the wheels steeled by Mr. Banks's process, and the result was, that whereas he was formerly obliged to repair the wheels of the tenders every four months, those with steel tyres did not require repair oftener than once in 12 months. He had not fully tested their wearing qualities, but he had no doubt that they would be found to be most economical as well as useful.—Several other of the members spoke in high terms of the value of this patent. **Civ. Eng. & Arch. Journ.**

Remarks on some of the Applications of Chemistry to Geological Research. By Prof. Daubeny.

The lecturer first noticed the phenomena of metamorphic action in rocks as requiring the aid of chemistry for their explanation. The formation of mineral veins belongs to this subject, and may be elucidated by two principles that have been pointed out by chemistry: viz. 1. That igneous rocks contain frequently disseminated through them infinitesimal quantities of most of the metals which exist in mineral veins. 2. That the latter are convertible into vapor at a temperature below their freezing point. After stating facts that lend support to both these principles, the lecturer pointed out their bearings upon the aggregation in veins of mineral matter derived from rocks that had

been subjected to long-continued heat, and concluded that their occurence in the neighborhood of plutonic and volcanic rocks might thus be accounted for. Another effect attributed to metamorphic action is the formation of Dolomites. Here carbonate of magnesia appears to take the place of carbonate of lime without actual fusion having occurred to produce it, since the organic structure of the fossils is often preserved in rocks so altered. Although the cause was different, the effect seemed analogous to that which has happened to certain sponges, &c., in the greensand near Farnham; where, according to a recent discovery, phosphate of lime appears to have taken the place of a portion of the carbonate with which the marine production was at first fossilized. The theory proposed by the lecturer, in short, differed chiefly from that of Von Buch in his supposing the magnesia to have been derived from other parts of the limestone formation, instead of the igneous rock injected. After recommending fresh experiments to be instituted for the purpose of setting at rest the question relating to the possibility of an actual transference of magnesia from place to place, the lecturer proceeded to point out the necessity of chemistry for the elucidation of the phenomena produced by igneous causes at the present day. He alluded to the various chemical phenomena which present themselves during the several *phases* of volcanic action, all of which ought to be kept in view by those who pretend to give a theory as to its cause. He pointed out the discovery of Mr. Grove, that heat is capable of overpowering the strongest affinities, as corroborative of the chemical theory by showing that if a temperature ever existed which was sufficient to render the most infusible bodies liquid, the elements of matter would probably have been at the time uncombined, so that when any portion of them sunk below that point, the very same chemical action must have commenced which this theory supposes to be going on at present. The absence of lime and magnesia from granite, and the redundance of silica in it, are also in accordance with this theory; and so, likewise, is the detection by Pella of flames issuing from Vesuvius, as the emission of hydrogen from volcanoes appears thereby substantiated. The lecturer then pointed out some of the final causes of the processes alluded to—as, for example, the offices discharged by the carbonic acid evolved from the earth in decomposing rocks and liberating their fertilizing materials, in the production of new limestone rocks on the surface to compensate for those converted into silicates by volcanic heat in the interior, and in the restoration of the purity of the atmosphere by supplying oxygen through its decomposition by plants. He also alluded to the accumulation in veins of the several metals through metamorphic action, without which, owing to their comparatively minute quantity, they could never have been recognised by man; whilst those bodies which, like phosphates, are essential to organization occur almost universally diffused. The lecturer concluded by entreating his hearers to call in to the elucidation of geological phenomena the assistance of chemistry, as a science which may be regarded as the grammar to the language of Nature—the key to unlock the most hidden of her mysteries.—*Proc. Roy. Inst., March* 24, 1848.

London Athenæum.

STATISTICS.

Notice of the Sardinian Exhibition of the Products of Industry, by M. Bonafous.—*Translated for the Journal of the Franklin Institute.*—The work which I have the honor to present is compiled by M. le Chev. Giulio in the name of the Royal Chamber of Agriculture and Commerce, and presents a classified table of the products of Sardinian industry admitted to the public exhibition which took place last year at Turin, with a list of the recompenses awarded to the most deserving of the exhibitors. I shall confine myself to noticing only a few of the arts.

There are at present worked in the kingdom of Sardinia, 28 mines of iron ore, which employ from 3000 to 4000 workmen, and produce 80,000 quint. metriq. of iron, value, 4,000,000 frs. ($800,000.) This product not being sufficient for the consumption, the rich Elba ore, and charcoal from Tuscany are transported to several points on the shore of the Mediterranean to supply other works, in which they prepare 30,000 quintals of iron by the direct method, which in France is called the Catalonian, in Italy the Ligurian process.

Add to this 8000 quintals of wrought, and 30,000 quintals of cast iron, and we get the amount consumed.

The establishments of this country also produce steels of a remarkable temper. In the exhibition of 1844, there were files which promised competition with those of Styria and of England. The iron wire, and hollow-ware also attracted attention. There are three mines of argentiferous lead, those of Pesey and Macot in the Tarentaise; those of Saint-Jean-de-Maurienne and of Tenda, produce only a mean value of 300,000 francs yearly. ($56,000.)

From 25 workings for gold only 500,000 francs are produced. ($93,500.)

Several copper mines are also but feebly worked.

Three mines of manganese furnish 35,000 kilogrammes of peroxide (34½ tons) fit for the manufacture of chlorine for bleaching linen and cotton goods.

Two mines of cobalt are neglected.

The pottery is almost entirely abandoned to the peasants. Yet about 100,000,000 pieces of bricks and tiles are produced, of which about one-tenth part is exported.

No glass is as yet made in the Sardinian states, but several manufactories of flint and bottle glass are in progress.

The chemical products amount annually to 300,000 francs. ($56,000.)

The Genoese paper a century ago was celebrated everywhere. At present, since England, and especially France, have paid attention to this article, it is only in Spain, Portugal, and South America, that the paper of Genoa is consumed.

Sardinian industry furnishes from 3 to 4,000,000 kilog. (3000 to 4000 tons) of leather coming from 8 or 9,000,000 raw hides, of which one-fourth are imported.

Silk holds the third rank in the scale of agricultural or national products of the kingdom after grain and wine, and is the most important object of commerce of the country. The annual production is estimated at 600,000 kil. (1,322,842 lbs.) of silk, having a value of about 38,000,000 francs. ($7,000,000.)

The silk-spinning establishments are about 1000, and employ 65,000 persons of all ages. Were it not for the loss caused by the *muscardine** in the cocooneries, this act would suffice of itself to pay the whole expenses of the government.

The cotton trade furnishes about 6,000,000 francs ($1,122,000) of spun-cotton, and employs more than 5000 workmen.

The woolen business, notwithstanding the competition of foreign cloths, which get access indirectly to the country, furnishes more than 1,540,000 metres (1,680,000 yds.) of stuffs of all qualities. To add to its importance, this manufacture awaits the time when it shall be freed from the necessity of using foreign wool.

Exports of Iron from Great Britain to the United States.—It will be observed, from a reference to the following table, that British exports to the United States have increased very much during the past year, expecially in the finer descriptions of iron. The shipments from Wales, direct to the United States, have also been much in advance of any former year. To India her exports have again been light.

Exports of Iron from Liverpool in 1846–7, to New York, Boston, and Philadelphia.

	Rails.	Bars.	Hoops & Sheets.
To New York, in 1846,	6,440	7,026	901
" in 1847,	6,642	20,546	4,355
Increase,	202	13,520	3,954
To Boston, in 1846,	6,030	4,114	623
" in 1847,	5,843	13,583	1,670
Increase,	....	9,469	1,047
To Philadelphia, in 1846,	44	1,667	162
" in 1847,	150	3,414	670
Increase,	106	1,747	508

Hunt's Merch. Mag.

Statistics of Railroads.—End of 1847, 1,395 miles of rail had been opened in France, 3,891 in Germany, 546 in Belgium, 342 in Italy, about 250 in Hungary, 213 in Poland, 183 in Holland, 138 in Denmark, 51 in all Russia, and 18 in Switzerland. Lond. Builder.

Gas Statistics.—It was stated by Dr. A. W. Hofman, in a recent

* A disease of the silk worm—a kind of mould or mouldiness which destroys it.

lecture at the Royal College of Chemistry, Hanover Square, on the composition of coal gas and its combustion, that in England nearly 6,000,000 tons of coal are annually consumed in the manufacture of gas, and from £12,000,000 to £15,000,000 employed in its production. In London alone 500,000 tons of coal are annually used, producing 4,500,000,000 cubic feet of gas, and 500,000 chaldrons of coke; of the latter 120,000 chaldrons are consumed in manufacturing the gas, and the remainder is sent into the market for fuel. The number of houses burning gas in London is more than half a million, and the length of the mains is upwards of 1,500 miles. Ibid.

Land in England—The whole area of England is equal to 50,387 square miles, or 32,247,680 statute acres: thus divided—arable land, 13,252,000; pasture, 12,380,000; and uncultivated, 6,615,680 = 32,247,680 acres. Lond. Min. Journ.

The State of Pennsylvania contains nearly 47,000 square miles, or 30,080,000 acres of land.

Produce of Gold in Russia.—Accounts from St. Petersburg give a summary of the returns of gold delivered from the mines of the Ural Mountains, during the half-year, ending the 31st December last. The quantity of gold produced in the royal mines during that period had been 60 puds. 27 lbs. 77 sol. 79 parts. The private mines had produced 101 puds. 24 lbs. 1 sol. 76 parts. The quantity of platina obtained from the Crown properties and from private mines had been 18 lbs. 92 sol. 17 parts. The royal and private mines in the Altai Mountains, and in East and West Siberia, had produced, in 1847, 1434 puds. 12 lbs. 57 sol. of gold; and the district of Nertschinskinche, 25 puds.,—making a total of 1780 puds. 37 lbs. 69 sol., for the year, 1847, independently of the silver obtained from the Altai Mountains and Nertschinskinche, which amounted altogether to 168 puds. 25 lbs. more than in 1846. Ibid.

Soap Returns.—By returns, just printed, obtained by Mr. Hutt, M. P., it appears that in the year ending the 5th of January last, 1,955,023 lbs. of silicated soap were made in Great Britain, 160,065,641 lbs of other hard soap, and 14,279,425 lbs. of soft soap. In the same period, the quantity imported into Great Britain from Ireland was 170,249 lbs. of hard, and 2560 lbs. of soft soap. The amount of duty was £1128 9s. 2d. The number of licenses granted to soap-makers in the year was 316, of which 147 carried on business in England, 19 in Scotland, and 150 in Ireland. Ibid.

The Coal Fields in England and Wales.—A Ruabon correspondent in the *Chester Chronicle*, signing himself "Asbestos," says, that the North Wales coal-field, measuring from the point of Ayr, in Flintshire, to a few miles beyond Oswestry, in Shropshire, covers an area of 200 square miles, of 10 yards in thickness. The weight of a cubic